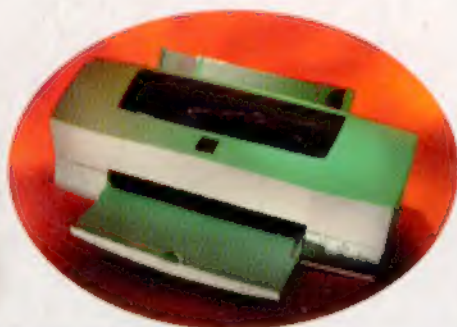


PC MAGAZINE

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- Quicken 99
- Lotus Organizer vs. Day-Timer
- HP Pavilion 8395 PC
- Norton SystemWorks
- Trellix 2.0



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THE INDEPENDENT GUIDE TO PERSONAL COMPUTING VOL. 17 NO. 19 NOVEMBER 3, 1998

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44>

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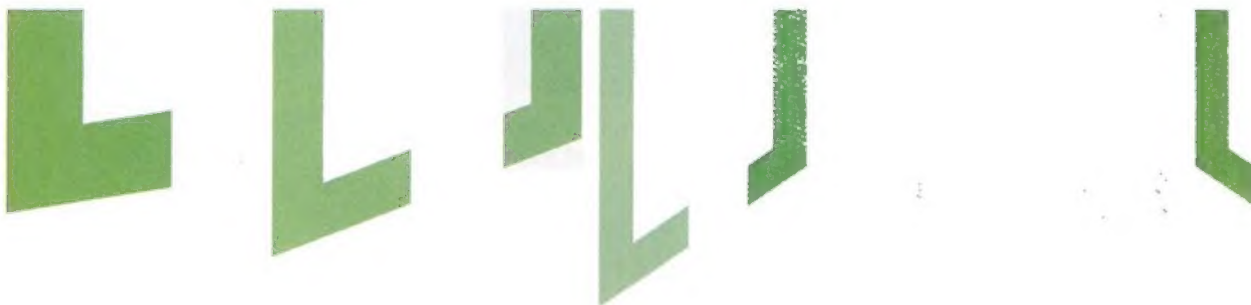
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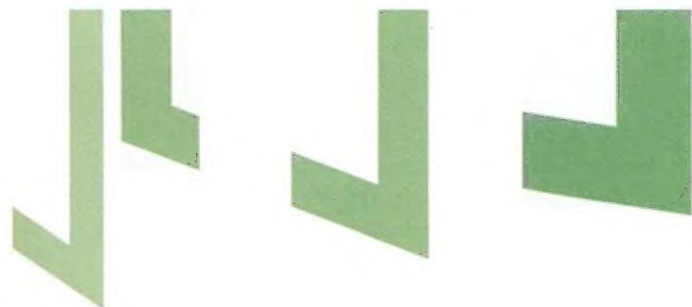


Is your network, or your company, the same as it was two years





ago? Neither is Windows NT Server 4.0.



On July 29, 1996, we introduced Microsoft® Windows NT® Server 4.0. The idea behind this server operating system, as with 3.51, 3.5 and 3.1 before it, was that customers would benefit from an OS that runs their network and their business applications. It was about integration, and it still is. But a lot has changed in two years.

To keep up with the changing needs of customers, we've added hundreds of enhancements since 1996. In fact, today's Windows NT Server 4.0 is far different from the one we first shipped. For starters, we've improved file and print performance, and updated Web and application services. We've also enhanced networking and communications services, and enabled streaming media. And, we're committed to continued improvement as we work to provide a solid migration path to Windows NT Server 5.0.

So how have these improvements been received? In just two years, about 640,000 U.S. companies have installed over 1 million copies.

A lot has changed in two years. Including Windows NT Server 4.0.



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Classroom Computing



We don't really see just how dramatically computers have changed our lives. When you compare the way we do things with computers and the way we did them without, the change is all the more startling.

This really hit me a couple of weeks ago, when I had the opportunity to talk to the incoming freshmen at Rensselaer

Polytechnic Institute, my alma mater.

I expected a big change in the tools the freshmen would be using, compared with the equipment I had as a freshman. The year before I entered, students were advised to get a good slide rule (because they would always use it). My class brought pocket calculators. Many of the students of the class of 2002 were carrying 3Com PalmPilots or Palm IIIs, and almost every one seemed to have a laptop computer.

In fact, of the 1,163 incoming freshmen, about 300 were getting new IBM ThinkPad 600s, each with essential software like Microsoft Office and Maple for mathematical analysis. That's more computing power than we had on the entire campus in my day.

I expected the tools to change. After all, those I use in my daily life—PCs, laptops, organizers, software, e-mail utilities, and the Internet—have changed as well. But what I didn't expect was just how dramatically computers have allowed educators to change the teaching process.

Acting provost Jack Wilson took me around to a variety of classrooms, many filled with modern computing equipment. The technology was impressive, but even more impressive was how it was being used.

Nearly all the freshmen have to take introductory physics and chemistry courses. When I was a freshman, such courses meant sitting in a huge lecture hall with 500 or so students, listening to a professor who perhaps had an overhead projector. Later recitations and lab sessions, each taught by a different instructor, supplemented the lectures. It worked, but it disconnected the experiments that students learned from the lecture.

Today, the same classes take place in modern "studio" classrooms with groups of 40 to 70 students.

In the physics classes, students listen to lectures (which can be stored on a server and then shown on-screen via a PC and an LCD projector), then swivel their chairs to an area that includes a PC connected to the campus network and other test equipment. Students can also connect their laptops to the campus network. They do the experiments tied to the lecture, guided

by the professor and various teaching assistants, and then they print the results and turn them in. They then turn back for the next part of the lecture. The focus is now on the faculty watching the students instead of the other way around.

The changes in chemistry took me even more by surprise, as they take place in the same 94-year-old building where I attended chemistry labs. The outside of the building is still the same, but inside it's been completely changed, with classrooms much like those used in physics (although the students need to leave the classroom and their PCs and move down the hall to a chemistry lab). Again, technology has allowed the lecture and the lab work to become much more integrated.

Does it work? Professor Wilson explained to me that in some cases, freshmen were learning the basics so well that they were advancing to more difficult subjects more quickly—sometimes covering topics that used to be taught only on the graduate level.

Not all the courses are taught this way, although the school hopes to change that for all the large classes in a few years. There is one introductory course, which was small when I was a student, that is now taught in the 500-person lecture hall. The subject is computer science.

On the whole, it's very impressive. It makes a part of me want to go back and do it all over again. And what's most impressive is not the technology but the way it is being used to change the way people learn. And that may be the biggest change of all.

A stylized, handwritten signature of Michael J. Miller in black ink.

MICHAEL J. MILLER



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BY ALFRED POOR AND JAMIE M. BSALES

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Web Graphics

BY LUISA SIMONE

A picture is still worth a thousand words—especially on the Web! And sure, you *can* use broader graphics packages, such as Adobe Photoshop and CorelDraw, to create Web graphics, but the Web carries some special baggage that you need to address with specialized software tools. So we set out to test all the different packages that help you create images for the Net. It's a hodgepodge right now, but we identify the tools that deliver what you need.....197

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3-D Made Easier



BY JAN OZER

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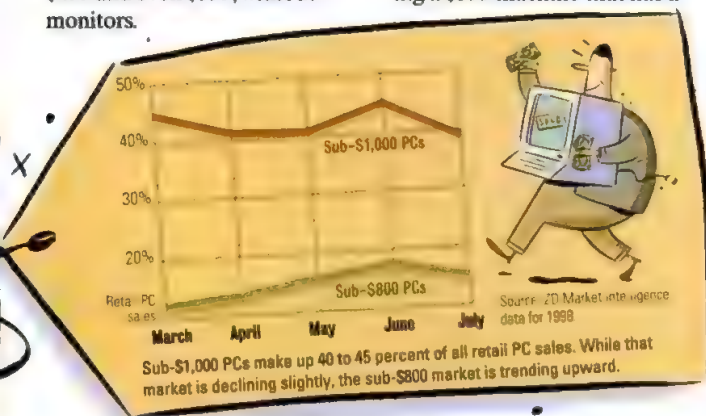
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Pipeline

The Bargain Bandwagon

Think PC prices have hit rock bottom? Think again. In 1998 sub-\$1,000 PCs flooded the market, but next year those machines may be considered pricey. PC companies are already starting to sell PCs for \$499 and even \$399, without monitors.

Although you won't find the top-tier PC makers in the lineup, there are several companies selling super-low-cost computers. What kind of horsepower will \$399 buy you? Micro Center stores recently started selling a \$399 machine that has a



According to Forrester Research, a new class of PC buyer is emerging, enticed by super-low prices. The market research firm predicts that first-time buyers will account for 40 percent of the home PC market in 1999, and that households earning less than \$35,000 annually will be the leading source of first-time PC buyers.

Another important shift is underway as well, with almost three-quarters of first-time buyers not using a PC at work. Until recently, almost three-quarters of PC owners had had computer experience before buying a home PC.

180-MHz Cyrix MediaGX MMX-enhanced processor, a 1.6GB hard disk, 24MB of RAM, a 24X CD-ROM drive, a 33.6K data/14.4 fax modem, and Windows 98. Other companies on the bargain bandwagon include Egghead, Gazelle Computer, Netram, Precisiontec, and Winchip.

According to ZD Market Intelligence, the low-cost market constitutes about 40 to 45 percent of the overall market. It also reports that while the sub-\$1,000 market is shrinking a bit, the sub-\$800 segment is growing, fueled by lower-cost microprocessors and memory chips.

The Phone Is the Network

Lately Intel has had its sights set on home networks that run over phone lines. The company recently started shipping to PC manufacturers samples of a new 1-Mbps chip—the Phoneline/Ethernet LAN Controller—for connecting PCs, printers, and other peripherals over plain old phone jacks.

“For consumers, home networking will solve the tug-of-war over printers and Internet access that occurs when a family buys a second PC,” says Dan Sweeney, head of Intel’s Home Networking division. According to market research firm Dataquest, more than 15 million homes in the U.S. have two or more PCs.

Shopping List

45%

of respondents to a recent PC Magazine Online poll told us that given \$1,500, they’d most likely buy a 333-MHz PC. 27% said they’d buy peripherals for their current PCs, 17% said they’d buy a value notebook, and 11% said they’d buy an iMac.

A Hard Disk That’s Hardly There

Engineers at IBM have invented the tiniest hard disk ever, and it’s slated to show up in hand-held computers, digital still cameras, digital video cameras, GPS navigation systems, and cellular phones as early as mid-1999. The IBM Microdrive is just 0.7 ounces and 0.2 inches high—plenty of room for 340MB of data.

Unlike flash memory, which is based on semiconductor technology, the Microdrive is a mechanical device with a spinning disk. According to IBM, the Microdrive offers a much lower cost per megabyte and can hold five times more content than a flash device.

Designed at IBM’s Almaden Research Center, the Microdrive is based on IBM’s giant magnetoresistive heads, which are ultra-sensitive to the disk’s magnetic fields and make it possible to detect smaller recorded bits (5 gigabits per square inch) and read them at high rates.

A Microdrive fits into a standard CompactFlash Type II slot, designed originally for flash memory cards. Canon, Hewlett-Packard, Hitachi, IBM, and Minolta are evaluating the Microdrive for use in future gadgets.



CHICKEN LITTLE: IBM’s Microdrive holds up to 340MB.

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Pipeline

Print, Only when Necessary

U.S. businesses waste more than \$5 billion a year on printed materials that become obsolete before they're ever put to use. That shakes out to 30 to 40 percent of all printed marketing materials.

In order to make print jobs more cost-efficient, Live Picture, Adobe, Canon, and Sun Microsystems are promoting the concept of network publishing. "Network publishing picks up where desktop publishing leaves off, by addressing the distribution of high-quality documents over networks," says John Sculley, chairman of Live Picture.

The technology is billed as a real money saver for businesses that produce documents

with slick infographics and complex images.

The heart of the new network publishing model is Live Picture's Image Server: It links FlashPix-built multiresolution images to Adobe Acrobat files and does the heavy lifting

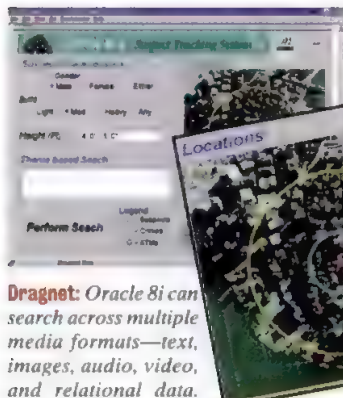
LivePicture's Image Server can deliver a 72-dpi version for rapid viewing on the Web or a hi-res 1,200-dpi image for printing.



of rendering the appropriate high-resolution pages for printing while serving screen-resolution pages for display.

Oracle's Internet Database

According to Oracle CEO Larry Ellison, the new "Internet database" Oracle8i is the key to his company's long-standing



Dragnet: Oracle 8i can search across multiple media formats—text, images, audio, video, and relational data.

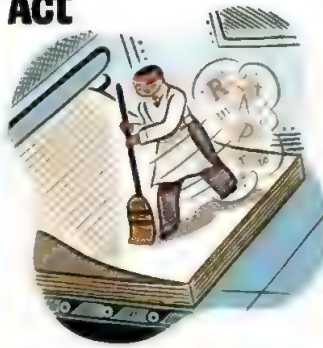
Java Virtual Machine for storing and executing Java code on a server. Ellison suggests that a developer working on an e-commerce Web site might write, store, and execute the Java code within Oracle8i, along with

nonrelational data.

Meanwhile, Microsoft has disclosed a long-term plan to build its SQL Server into Windows NT's file system, but this won't happen in conjunction with the release of Windows NT 5.0. That leaves it up to Webmasters to decide whether a database-centric platform or an OS-centric platform is best for managing their sites.

THIS ISSUE'S CONTRIBUTORS: Angela Hickman, Carol Levin, Sebastian Rupley, Don Willmott.

Disappearing Act



Hoping for a paperless office? Fat chance. With the proliferation of printers, copiers, and fax machines, corporate America is using more paper than ever. By some estimates, U.S. companies feed their copiers more than 81 billion sheets of paper a month, at a cost of \$600 million.

Inventor Sushil Bhatia—CEO of Decopier Technologies, based in Framingham, Massachusetts—has come up with a solution. The Decopier works by applying a nontoxic chemical at low heat to a sheet of printed paper in order to soften and loosen the toner and ink. A brush then sweeps away the flakes, and a spanking-new, clean sheet of paper emerges from the other side of the environmentally friendly machine, ready to be reused. Bhatia has perfected the chemical process, which uses a pasty liquid to remove the ink and toner instantly.

The Decopier is positioned not only as a way to save paper costs but also as a security tool that erases sensitive documents.

Slated for launch by year's end, the first version of the 60-page-per-minute, \$45,000 Decopier will be aimed at commercial "decopying" centers. There are plans for a personal version for under \$2,000.

Top-Selling Retail Desktops

1	HP Vectra VL7 PP266 (\$1,337)
2	IBM PC 300GL PP266 (\$1,158)
3	Compaq Presario 5030 PP300 (\$1,370)
4	Compaq Deskpro EN PP266 (\$1,196)
5	HP Pavilion 6340 C300 (\$1,014)
6	Compaq Deskpro 4000 PP266 (\$1,262)
7	IBM PC 300PL PP350 (\$1,763)
8	IBM PC 300GL M200 (\$845)
9	Compaq Deskpro 2000 M200 (\$845)
10	Compaq Presario 5020 C300 (\$1,152)

Source: ZD Market Intelligence.
Data for August 1998

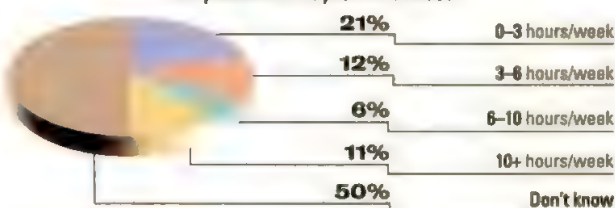
Self-Aware Web

The latest twist in Web caching comes from newcomer InfoLibria, which has come up with a way to put its caching hardware throughout the Internet and let the caches "discover" each other.

"The Internet is good at routing but oblivious to content," says Abdelsalam Heddaya, vice president of research and architecture. This situation makes the Internet repeatedly send the same data over the backbone and send redundant requests to overloaded servers. But InfoLibria's new content-aware caches can share such information and move content more efficiently. InfoLibria says its DynaNet technology can increase access speed up to five-fold and decrease bandwidth use by up to 60 percent.

How Much Are Your Kids Surfing?

When asked how much time their kids spend online in a week, half of the parents surveyed had no idea.



Source: SurfWatch Software.

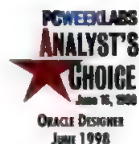
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THE TURN OF THE THUMB- screw.

It was a dark and stormy night, Monday no less. From the bowels of Pistons, Inc., came howls of triumphant laughter. For weeks, Mike, the IT Director, had felt the pinch of their tech costs and his management's mandate to cut them. They always seemed to be robbing Peter to pay Paul for PCs, printers and software upgrades. Plus more departments needed ¹(more customized AS/400 apps). Something had to change. Earlier that day he had met with his ²(partner), who told him how he could ratchet their company into an e-business machine without paying through the nose. So you're saying, Mike asked, that we can ³(Web-enable our AS/400s) while ⁴(turbocharging our e-mail system)? Yes, the partner said. Implement ⁵(document management) and ⁶(integrate my AS/400 data with PC applications)? Yes. Everything? Yes, and very quickly too, the partner added. Now as he read through the proposal he'd present tomorrow, he again laughed the laugh of some mad scientist and shouted: Get ready Betty, I'm happy whappy! Just then there was a knock at his door. The security guard looked in and asked, Everything all right, sir? Couldn't be better, said Mike smiling.

THE ⁷(HAPPIEST MOMENTS) OF HIS DAY WERE MADE POSSIBLE BY LOTUS.

¹Lotus Business Partners provide thousands of Domino™ apps. ²AS/400 partner. ³Utilize Lotus Notes Designer for Domino.™

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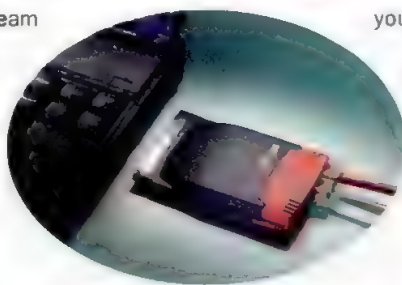
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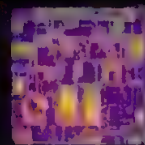
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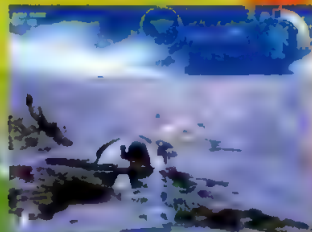
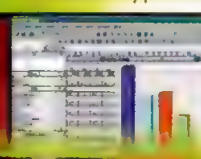
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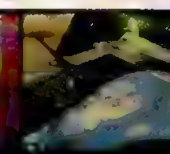


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Letters

A DISAPPOINTING PATTERN

I was disappointed when I saw your list of so-called "most influential companies" ("The PC Magazine Most Influential Companies," September 22). Your articles in recent years have followed a disappointing pattern too: You praise Microsoft products and rarely point out their shortcomings. Why not change your magazine's name to *Microsoft/PC Magazine* (or *PCs-That-Use-Only-MS-Software Magazine*)? Companies such as Caldera and Red Hat have developed Linux distributions that make it easy for people to set up cheap and efficient servers and workstations. I think companies like these should be considered influential for allowing users an inexpensive alternative to Windows.

CARSON FENIMORE
via the Internet

BE EFFICIENT

Interesting parallels can be drawn between the computer and automobile industries. During the sixties, lazy automotive engineers designed cars with huge and unsophisticated 6- and 7-liter engines. Who cared? Gas was cheap, and folks didn't worry about fuel efficiency, pollution, and other un-American stuff like that. Because of increased environmental awareness and the OPEC scare of the mid-seventies, the U.S. government stepped in and actually forced auto manufacturers to start cleaning up their act. As expected, all automobile manufacturers cried bloody murder and claimed that the new de facto standards could not be met. Fortunately for us, the government regulators stood their ground. Today we are driving cars with well over twice the net horsepower output per engine of the best unregulated cars of the sixties, while getting twice the fuel efficiency and emitting a tenth (or less) of the pollution.

In the computer world, horsepower and fuel (the CPU, chip sets, RAM, and data storage) are very cheap and are getting cheaper every year. As a result, today's programmers do not have any reason to write elegant, efficient code. I'd even venture to say that most of them would prefer to have their customers wait for Intel's new, more powerful chips to run bloated code rather than spending time really polishing their programming. Intel, of course, is only happy to oblige and keeps on turning out ever faster processors.

This state of affairs produces a vicious circle in which ever higher CPU power is immediately obliterated by ever more bloated, buggier programming. Any wonder why more and more people—including yours truly—are quickly stepping off this carousel and are refusing to participate in the futile upgrading exercises (best illustrated currently by the emer-



"Why not change your magazine's name to Microsoft/PC Magazine?"

gence of the 400-MHz Pentium II and Windows 98)? Ralph Nader, where are you when we really need you?

RAFAEL GUTIÉRREZ
via the Internet

MONITOR THE REVIEWS

In "LCD Monitors Go Digital" (First Looks, September 22), as in your previous articles about LCD monitors, you say that a 14.1-inch LCD provides an image that's "functionally equivalent" to that of a 17-inch CRT. I don't see how anyone could compare a 14-inch LCD with a 16-inch-viewable CRT. You should be comparing those \$1,000 14-inch LCDs with \$250 15-inch CRTs. We all want flat panels to replace our clunky CRTs, but comparing apples and oranges won't get us there.

In the same article you're surprised that an analog thumbwheel is easy to use. What on earth could be more simple or ergonomic than a thumbwheel?

NICOLAI MICHEL
via the Internet

SPEED DEMONS

Michael J. Miller's editorial "Built for Speed" (September 22) is the goofiest piece of work I've read in a long, long time! Mr. Miller says that today's computers aren't good enough. He cites games, DVD, power-user spreadsheets, videoconferencing, and the like as reasons why we need ever more powerful computers in the next several years. These examples are misleading and irrelevant. Sophisticated 3-D games are very much in the minority; most can still run on a standard Pen-

tium machine. Furthermore, I don't use my computer to play games, nor do most of my friends and colleagues. Although a significant cadre of serious PC gamers are certainly out there, they hardly drive the PC market. My friends' young children even play games on their lowly 486s.

And if I want to watch movies and DVD, I'll do so on my television, thank you very much. Spreadsheet recalculations that take hours or days? Surely these users are in the minority. Since the beginning of computing there have always been users on the leading edge, but such people do not drive the sale of PCs. Ditto for videoconferencing, biometrics, and speech recognition. I don't believe for a second that speech recognition will become commonplace within the next five years.

Miller's long-term vision for future computing is laudable, but none of it will be pervasive anytime soon. A computer you buy today will have an expected life of about four or five years; you'll discard it well before the demand for these types of CPU-hogging applications becomes strong. Indeed, today's computers are fast enough.

RICHARD ENG
via the Internet

I have to disagree with Michael J. Miller when he says that computers are not fast enough. Although he makes a valid point that certain types of applications—those requiring graphics rendering, for example—will always require as much speed as possible, I think he looks past a serious issue. Fast computers have made programmers lazy. When 8-MHz computers were king, the best programs were those written using ingenious tricks and real programmer talent. These days, it seems that programmers bank on raw computing speed to take care of shortcomings in design. Should an operating system really require a 125MB footprint and take over 5 minutes to boot up? I don't think so. I think programmers should stick with the slow processors and try to optimize their code. Maybe then we wouldn't be so worried about having slow computers in need of upgrading and we could spend more money where we should be spending it: on software.

ALBERT C. LEE
via the Internet

SUITE STUFF

The article "Professional Graphics" in your September 22 issue is significantly deficient, since it fails to mention Micrografx Designer even once—a program distinguished from all other vector drawing programs by a reasonable price, small footprint, and extraordinary range of integrated file-translation utilities.

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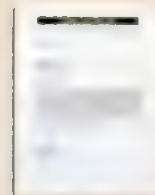
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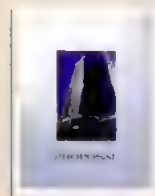
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Letters

Furthermore, Designer's capabilities are not significantly lesser than either CorelDraw's or Illustrator's. A comment would have been in order if a new version was expected soon and the publisher had asked not to be included.

BILL KIDD
via the Internet

Micrografx Designer is no longer a standalone product. It has been incorporated into Graphics Suite, which will not have a new version until the first quarter of 1999.—Ed.

BE REALISTIC

John C. Dvorak's otherwise excellent column "New and Unimproved" (September 22) fails to recognize the reality of the marketplace. First, the physical properties of a computer monitor make warming a hamburger or its bun impractical. Second, the staple food of computer nerds is cold pizza, not hamburgers. The obvious solution is the integrated monitor/pizza oven. The 19-inch version provides energy efficiency and can bake a standard large pizza in the rated time. The 17-inch will handle only a medium pie and requires a 10 to 20 percent increase in baking time, because of power conservation. Smaller versions, suitable for warming individual slices, are under development. Venture capitalists are invited to contact the author for design details and patent references. The concurrent development of a crumb vacuum for monitors and CPUs is being considered, and a prospectus will soon be available.

MIKE RICHTER
via the Internet

XTRAORDINARY SOFTWARE

Like John C. Dvorak (Inside Track, September 22), I've long lamented the demise of the venerable Xtree. (The DOS and Windows versions were integrated into Central Point Software's

Corrections and Amplifications

In the September 1 issue, the phone number for IVI Publishing (which has since changed its name to OnHealth Network Co.) was incorrect. The correct number is 800-952-4773.

In our July article "Readers Rate Printer Service & Reliability," Okidata should have received a grade of C on our report card. Its scores on our four key measures—satisfaction with printer reliability, with repair experience, and with tech support, and whether units needed repair in the past 12 months—are average, so Okidata receives a respectable C.

In "Server NICs with Tricks" (September 22, 1998, page 203), the company name ZNYX was misspelled.

stable, and then Symantec swallowed Central Point.) Not that I have that many complaints about Norton Utilities; it's just that Xtree did things I could trust—things that nobody else's products, including Norton Navigator and Norton Utilities, got right. So after reading Dvorak's column I immediately downloaded Ztree. It's everything you say it is—seemingly a dead ringer for XTreeGold 3.0, which I still have and use on my old 486. Well, not completely equivalent, but close enough.

LYN ROBINSON
Redlands, California

RIGHT-CLICK PRINT

The September 1 User-to-User discussion of the method for adding a Print Directory command to the right-click menu was extremely helpful. This is a function that we all need at least once in a while; most of us need it all of the time. Although the author, Neil J. Rubenking, gave us several ways to configure the command, he omitted one that I really need. Why not also tell us how to add the Print to File command also? Sometimes we may need to store this information for use at a later time when the contents of the directory may have changed. If this is a possibility with the right-click menu, I would love to see it in an upcoming issue.

CARRIE ODER
via the Internet

USE A DIFFERENT OS

Regarding the letters about Windows 98 in the September 1 issue, if so many people are questioning the reliability, stability, ease of use, and general usability of Windows, why not use a different operating system? Too bad most major publications—including your own—have overlooked an operating system that stands solidly on its own two feet. Which OS provides your choice of console or GUI operating mode? Which OS provides a central repository for user configurations that not only are compatible across machines but also roam the LAN? Which OS is designed from the ground up as a true 32-bit multitasking workhorse? Which OS measures its downtime in minutes per year? Which OS is so powerful, flexible, and stable that the U.S. Postal Service relies on it to handle the handwriting recognition tasks required to route our nation's mail? Which OS is free?

The answer: Linux. I run it on my home machine as well as on the servers I maintain at

work, and never do I say to myself, "Gee, I wish I could do that with my computer." Granted, Linux is a little weak in the games category, but many individuals and corporations out there are quickly fixing that problem. For example, ID Software makes Linux versions of its most popular games (DOOM, Quake, and Quake II). In other areas of home computing, Linux stands tall too. ApplixWare has a complete SOHO solution—with spreadsheet, word processor, and presentation applications—and Netscape Communicator is available for Linux. Further, Corel has announced that it will port all of its commercial applications to Linux, including Corel WordPerfect Suite 8.

I say download Linux and tell Bill to keep his bugs.

STEVEN KORDIK
via the Internet

WINDOWS CE DEVICES VS. THE PALM III

Jim Seymour's suggestion in "Navigating the Shoals of PDAs" (September 22) that those not already using a 3Com Palm device should concentrate on the Windows CE devices is a disservice to his readers. Certainly anyone contemplating buying a PDA needs to evaluate the Windows CE devices, but ruling out the Palm III on the basis of Seymour's arguments would be ill advised.

Concentrating on the Cassiopeia, Seymour argues that it is a "better, more useful" choice than the Palm III, based on little more than the Cassiopeia's voice-recording support and better backlight. Glossed over is the fact that the hand-held Windows CE devices as a class are bigger and heavier than the Palm III, have battery lives ranging from disappointing to dismal, and are slower and more cumbersome to use. Voice recording is a great gee-whiz feature, but it has little actual use for many users. Voice notes are not searchable, so finding one among many is tedious, and the devices' memory is not sufficient to accommodate dictation of any significant length.

As for the screen and backlight, the Palm III could certainly be improved, but the Cassiopeia's abysmal battery life is too high a price. Seymour implies that if you're not already in the PalmPilot camp, you should ignore it. You'd be smarter to look at all the choices and make an informed decision.

TOM BRIDGMAN
Croton-on-Hudson, New York

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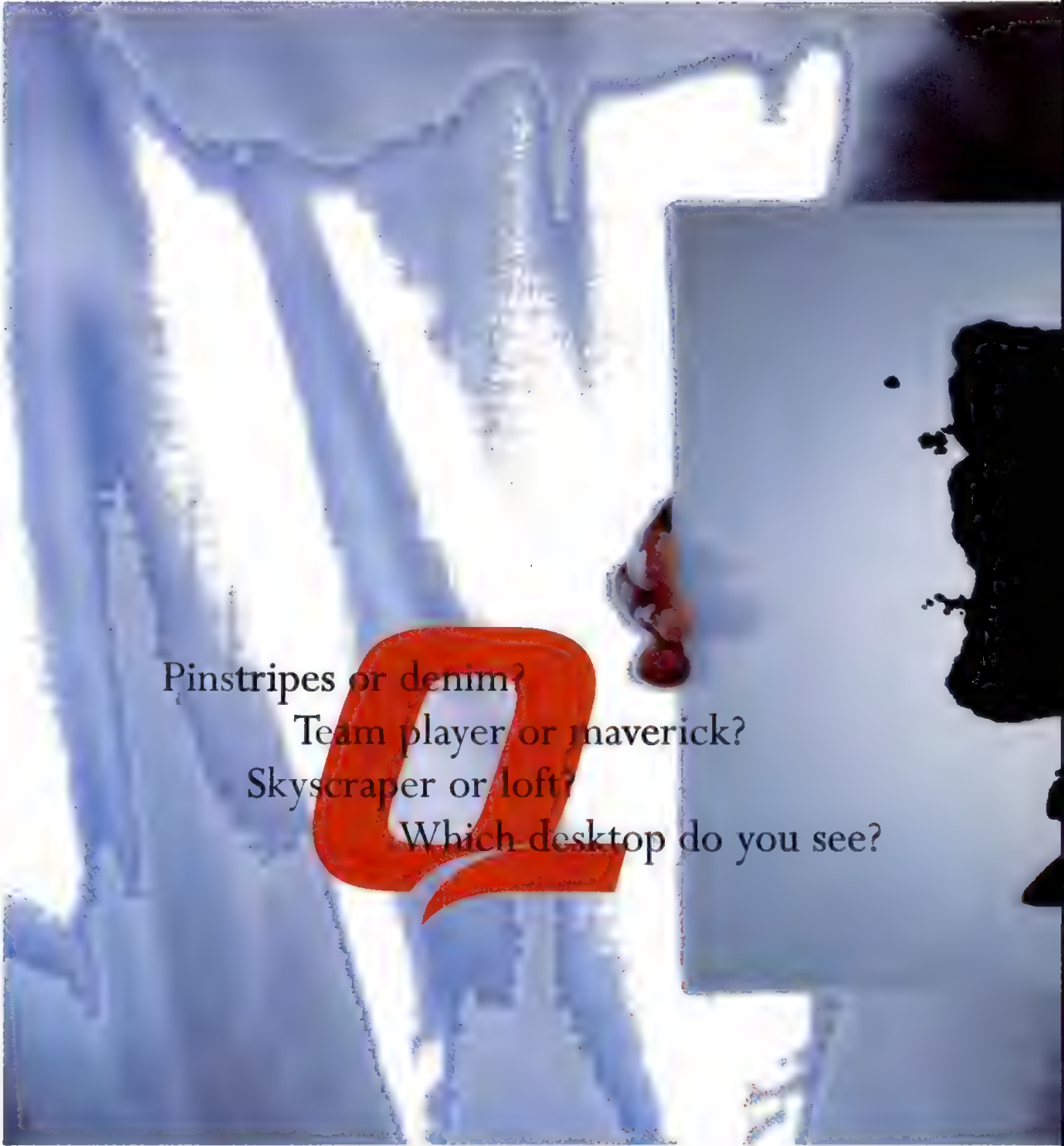
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Trends

A New Kind of Telco

The IP and phone networks have some great apps in store.

At first, Internet telephony held forth the tantalizing promise of practically free phone calls—local, long-distance, anywhere, anytime. The prospect of transmitting voice as packets of data over the Internet Protocol (IP) network spooked the telephone companies. After all, a network that ran parallel to the public switched telephone network would have posed a serious threat. But so far long-distance bypass, as it's known, has proved less formidable than expected.

In fact, the traditional phone companies are no longer standing on the sidelines watching young telecom upstarts muscle in on their business. Internet telephony could turn out to be as much about nifty new services, such as Internet Call Waiting and push-to-talk buttons on Web sites, as it is about saving money on long-distance calls. Although Internet telephony is currently exempt from the federal regulations and charges applied to traditional telephone companies, that exemption may not be around forever.

"There will be more of a level playing field in the future," says Buzz Schadel, vice president of corporate marketing at eFusion, a developer of IP telephony software. "As the regulatory playing field gets flat, the opportunity to undercut the regular phone companies on price gets skinny. The industry sees a lot of the future attention shifted to enhanced services, more than just basic telephony service," he says.

Not everyone agrees. Newcomers such as Level3 and Qwest are moving full-steam-ahead with their vast fiber-optic networks, which carry images, data, and voice over IP. According to Qwest, its "hyperspeed" network would be able to transmit the entire contents of the Library of Congress across the U.S. in 20 seconds. Qwest's service Q.Talk is now available throughout California, where subscribers can use their telephones to make calls over Qwest's IP network.

Meanwhile phone companies throughout the U.S. and Europe are getting cozy with Internet telephony developers, such as eFusion and VocalTec, to combine IP telephony services with regular old phone service. eFusion is currently running trials of its Internet Call

another phone (say a cellular phone), or instruct voice mail to record a message. Such a service would cost from \$5 to \$15 a month.

Another potentially popular feature, designed for e-commerce Web sites, is the push-to-talk button. Let's say you're on a Web site buying a computer and need to speak direct-

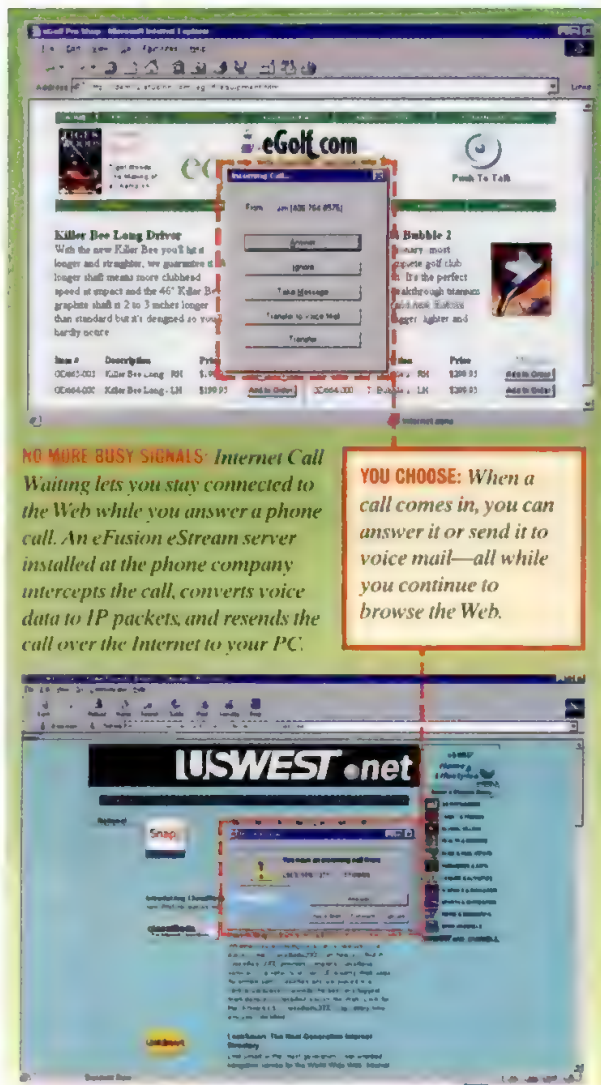
ly and immediately with a live customer-service rep. You click the push-to-talk button and a customer-service rep answers your questions as you continue to browse. According to market research firm Forrester Research, two-thirds of all e-shopping carts are abandoned because potential customers can't get their questions answered online.

VocalTec Communications, which pioneered the concept of Internet telephony, and Deutsche Telekom Canada recently launched a phone-to-phone commercial service using VocalTec's IP telephony software. Deutsche Telekom will sell debit cards to link residential and business phone callers in Canada to over 100 countries worldwide. The developer is also planning a pilot with Israel's Bezeq International to offer low-cost phone-to-phone calls over the Internet from Israel to the United States.

In conjunction with Lucicent Technologies, VocalTec recently announced a significant technology advance that promises to set the stage for even better integration of the IP and phone networks. The companies say

they've demonstrated the first true interoperability between IP telephony gateways, which bridge traffic from traditional telephony to IP networks.

All this activity on the IP telephony front is likely to add up to more Internet options from your telephone company. Enhanced IP telephony services are now undergoing trials in the U.S. and Europe, with services to be commercially available in the fourth quarter of this year. —Carol Levin



Waiting and push-to-talk services with Ameritech, France Telecom, the Netherlands' KPN Telecom, Telecom Italia, Sweden's Tel-Nordia, and U.S. West.

Here's how it works: You're online and a call comes through over your telephone. Instead of the caller getting a busy signal, a window pops up on your computer screen informing you of a phone call. You can then choose to take the phone call over your PC while you continue to surf, redirect the call to

Sun's Java Card Gets Personal

With a smart card in hand, access to the desktop is at your command.

The last place network computers will be is on the desktop, but they'll be everywhere else," says Sun Microsystems CEO Scott McNealy. At a recent conference for Sun customers, he demonstrated some of the futuristic applications he envisions for a wide assortment of Java-based gadgets. They center around the Java smart card as a universal access device and the Jini (pronounced "genie") technology for easily connecting all kinds of devices—from printers to coffee makers—over a network.

Instead of toting around a notebook on business trips, imagine carrying only a Java smart card. That's all you'll need to turn any computing device you happen upon into your own personalized, secure desktop. For instance, from a hotel room set-top box (one that's equipped with a Java card reader), you'll be able to call up your own customized Web-based desktop—with all your apps and e-mail—on the hotel TV.



Sun CEO McNealy: Any device will be a personal device.

"We want to use Java cards to turn any available device into a personal device," says McNealy. Sun employees, for example, could use the chip-based Java cards to store their company IDs, building privileges, and lunch tickets. An employee could use the card to select an office for the day. Slipping the card into the office's phone and computer provides access to the employee's personal desktop and phone.

With a Java smart-card reader in your cellular phone, you'll be able to read e-mail in a secure, encrypted, and authenticated environment. And from a PalmPilot outfitted with a Java card reader, you'll be able to call up an interface for controlling the home thermostat or even for starting your car to warm up the engine when it's cold out.

On the lighter side, even a toaster or a coffee maker could be part of your Java federation. Then you could log on to your home network through the set-top box in your bedroom, call up the coffee-maker interface, and select the number of cups you'd like brewed. The Java-enabled Java maker would then grind and brew as instructed.—Carol Levin



PC Magazine Labs' first evaluation of the iMac (posted on our Web site at the end of August, and appearing in our issue of October 20, 1998) praised the system for its ease of use, styling, performance, and appeal to its target market. And we pointed out the drawbacks: It doesn't include a rewritable/removable storage device such as a floppy disk, Zip, or SuperDisk drive, and it relies on nascent USB technology for peripheral connectivity.

We also challenged Apple's performance claims, which touted the \$1,299 iMac as up to three times faster than a "similarly priced" x86-based system and up to 40 percent faster than a \$2,400 Pentium II 400-MHz system. Our testing showed that the iMac fell far short of Apple's claims. We politely scolded Apple for presenting such limited and questionable performance results.

As a result, *PC Magazine* received more than 300 responses from Mac advocates who charged us with mercilessly slamming the iMac and criticized our tests as unfair and designed to make the PCs look better. Readers contended that we should have used more graphics memory in the iMac, because it came equipped with only 2MB of SGRAM; a comparably priced 333-MHz Dell Celeron system came with 8MB. The goal of our testing, however, was to compare the iMac with a "similarly priced PC" and a 400-MHz Pentium II.

Readers also questioned the price comparability of our tested configurations. We upgraded both the Dell Celeron system and the iMac to 64MB of memory. The Dell Celeron PC included a 333-MHz microprocessor with 128K of L2 cache, 64MB of RAM, a 6.4GB hard disk, a floppy disk

drive, an ATI Rage Pro Turbo subsystem with 8MB of graphics RAM, a 32X CD-ROM drive, a Turtle Beach Montego A3D 64-voice PCI sound card, Harmon/Kardon HK-195 speakers, a 15-inch monitor, a U.S. Robotics 56K modem, an Intel 10/100 PCI Ethernet card, and a three-year warranty, with the first year onsite. The system's total price was \$1,637.

We upgraded the \$1,299 iMac to 64MB of memory (\$99). But if you add a floppy disk drive (\$120), 4MB of SGRAM (\$50), and a one-year onsite service contract (\$80), the price comes to \$1,648—nearly identical to the Celeron's. Still, the iMac has 2MB less graphics memory, 2.4GB less disk space, a 24X CD-ROM drive, smaller speakers, and a shorter warranty. We think we conducted a valid price/performance comparison.

In response to the complaints, we retested the iMac with 6MB of graphics memory,

which allows more room for bitmap caching for some 2-D apps and permits higher color depths. More important, it provides 3-D apps with additional space for double buffering, texture memory, and higher-precision Z-buffers. Not all graphics functions, however, derive performance benefits from more graphics memory.

In both the 2MB and the 6MB graphics memory configuration, the iMac performed virtually the same on the Quake demo. Adobe Acrobat Scroll, Excel Screen Update, and

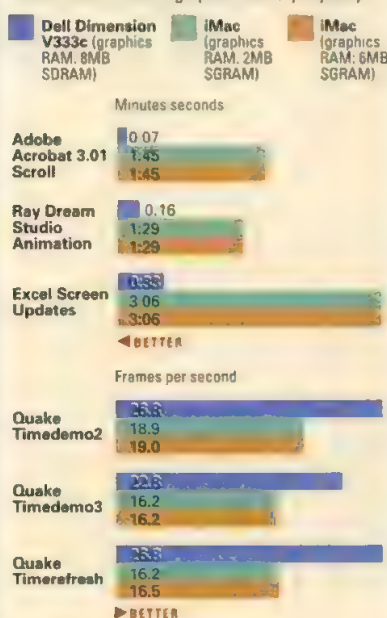
Ray Dream Studio tests.

In terms of the graphics memory usage with the tested application functions, we concluded that the iMac was not at a performance disadvantage compared with the PC. The iMac is an easy to use and speedy system, but we did not find it to be up to three times faster than a comparably priced PC.—Nick Stam

iMac Performance: Fact and Fiction

Our SGRAM Inspection

On graphics performance, the iMac lagged behind a comparably priced Celeron-based PC, even after we loaded the iMac to its graphics memory capacity.



Linux's Shot of Adrenaline

Look who's sitting up and taking notice of this free operating system.

Linux—a freeware version of Unix—has become a remarkable phenomenon in recent years, although it's been around since 1991. Programmers worldwide are adding to the platform on a constant basis by submitting proposed changes to Linux distributors or directly to the program's original author, Linus Torvalds. The largest collaborative programming effort ever, the platform has more than 7 million users, and by some accounts it's the fastest-growing Unix platform. Intel and Oracle are the latest companies to throw their support behind Linux.

Intel is planning to release its 64-bit Merced chip by the summer of 1999; in addition to supporting Windows NT, Merced will support Linux, according to Sunil Saxena, head of Intel's Microcomputer Software

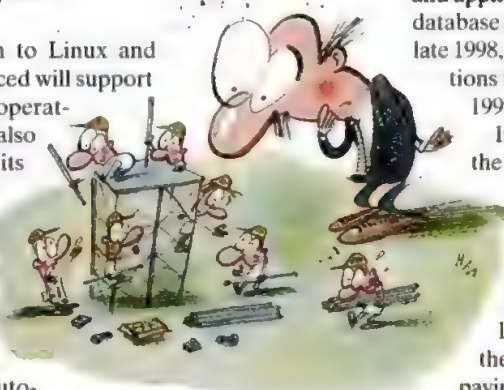
Labs. (In addition to Linux and Windows NT, Merced will support HP's 64-bit Unix operating system.) Intel also plans to build its Wired for Management features (currently available for Windows users) into Linux. IT managers use Wired for Management to automate the management and diagnosis of systems and peripherals on corporate networks.

Meanwhile, Oracle has formed technology and marketing partnerships with four Linux software developers: Pacific High Tech, Red

Hat Software, SuSE, and VA Research. And it's currently developing Linux versions of the Oracle 8 database and applications. The Oracle 8 database for Linux will ship in late 1998, and Oracle's applications for Linux will ship as 1999 begins.

Intel and Oracle aren't the only companies sitting up and taking notice of Linux's growing popularity. Microsoft president Steve Ballmer recently acknowledged that the Redmond giant is paying careful attention to

Linux's adoption rate. Although he emphasized that customers care more about the total cost of a project than they do about getting software for free, he did express concern. "Sure, we're worried," he said.—*Sebastian Rupley*



JAKE KIRCHNER

Isn't Congress Supposed to *Fight* Sex on the Internet?

When independent counsel Ken Starr's report to Congress was released to the public via the Internet recently, it was one more sign that the Web is a part of the daily lives of most Americans. All the people who have pointed to pornography as an early promoter of new technologies, including the Web, didn't guess that would be especially true of presidential porn.

A year ago, no congressional committee would have turned to the Internet first; the audience wasn't big enough, and the technology wasn't as comfortable for legislators—and their constituents—as it is today. But even Americans who rushed to the Web to get their first view of the report no doubt later turned on their televisions and picked up newspapers to get the analysis and arguments pro and con that are helping shape our view of the Clinton sex scandal.

Although the Internet is now a trusted information-delivery vehicle, it isn't yet a full multimedia solution for news and entertainment. But that's changing quickly. The talking heads and news analysis are already on the Web; they just aren't delivered well enough to keep people from turning to traditional information sources.

The biggest hurdle to the full flowering of the Internet isn't public acceptance. Despite the Internet's limitations, news and entertainment are already drawing as many people to the Web as hit television shows reach on a weekly basis, according to RealNetworks (whose RealPlayer is the leading vehicle for delivery of multimedia content).

When we visited RealNetwork's headquarters in Seattle recently, Dave Richards—head of Real's consumer group—told us that more than 500,000 people tuned into the Web in a matter of days to see the birth of a baby broadcast live across the Internet



in June by MCI and Real (www.ahn.com). The number of viewers, although impressive, isn't too surprising. More than 30 million people are registered users of the company's software for accessing content on the Web. On the production side, hundreds of organizations (including *PC Magazine's* parent, Ziff-Davis) use Real's technology to present streaming multimedia on the Internet. More than 300,000 Web sites use Real's products to create streaming audio and video.

Still, there are technological hurdles to overcome. Rob Glaser, Real's chairman and CEO, describes the Web's ability to provide multimedia content as "sort of like Windows on a 286." Real's new technology, RealSystem G2 (which is available from the company's Web site in beta), is a step forward but not the complete answer.

At Real we saw demonstrations of news applications that combine hyperlinks to regularly updated archives of articles, streaming digital photos and real-time video and audio, and stock tickers and news headlines. In another year, we'll see enough Americans with cable modems, DSL telephone lines, or direct satellite access to the Web that those applications will be able to be delivered with full-screen, full-motion video and stereo surround sound. At that point news, entertainment, and other media companies (record labels, for example) will all turn to the Web first. And not just for special events.

Of course, the PC makes for a pretty expensive television, so this Web-based content is going to have to be a lot more compelling than TV fare. Once the technology to support this now-fledgling content industry arrives, use of the Web is going to increase even more dramatically. The audience, after all, is already there waiting.



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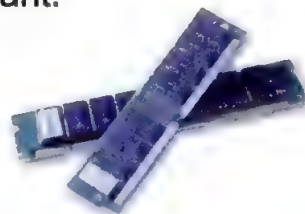
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Pavilion 7050, 7055, 7070, 7090	219.96	109.98	59.98	Aptiva (2168), Model M62, M61, M53, M71	219.96	109.98	59.98
Pavilion 7110Z, 7120, 7125	219.96	109.98	59.98	Aptiva (2176), Model C55, C65, C66, C67, C73, C77	219.96	109.98	59.98
Pavilion 7270, 7280P	219.96	109.98	59.98	PC 300 Series Pentium Systems (6x7x-, 6585-)	219.96	109.98	59.98
Pavilion 8160, 8140, 8130	219.96	109.98	59.98	Aptiva (2168), Model M62, M61, M53, M71	241.98	119.98	59.99
Pavilion 8180, 8175, 8176	219.96	109.98	59.98	PC 300GL Series Pentium II Systems (6561)	219.96	109.98	59.98
Pavilion 8190, 8240, 8246, 8280, 8275, 8260	241.98	119.98	59.99	PC 300XL Series Pentium Systems	239.98	119.98	59.99
Pavilion 8290	299.98	139.98	69.99	PC Server 320	263.98	131.98	79.98
Vectra VL 5/xx Series 3 PC	219.96	109.98	59.98	PC Server 330 PENTIUMII	279.98	139.99	79.99
Vectra VL 5/xx MT Series 4 PC	219.96	109.98	59.98	ThinkPad 310ED	N/A	219.99	99.99
Vectra VL 5/xx Series 4 PC	219.96	109.98	59.98	ThinkPad 365X, 365XD	N/A	N/A	99.99
				ThinkPad 380, 385	N/A	N/A	99.99
				ThinkPad 560	N/A	219.99	99.99
	128MB Upgrades	64MB Upgrades	32MB Upgrades				
Apple							
iMac	399.98	199.99	99.99				
Mac LC III	N/A	109.98	54.99				
Performa 5400, 6360, 6400	N/A	159.98	79.99				
Performa 6110CD, 6112CD, 6115CD	N/A	109.98	59.98				
Performa 6116CD, 6117CD, 6118CD	N/A	109.98	59.98				
Performa 6200, 6300	N/A	109.98	59.98				
Power Mac 5200/75 LC, 5260, 5300	N/A	109.98	54.99				
Power Mac 5500 Series	249.98	124.99	79.99				
Power Mac 6100 Series	N/A	109.98	59.98				
Power Mac 7100, 8100 Series	219.96	109.98	59.98				
Power Mac 7200/75/90	319.96	159.98	79.99				
Power Mac 7500, 7600, 8500	319.96	159.98	79.99				
Power Mac 9500 Series	319.96	159.98	79.99				
Power Mac G3 Series(M6141LL/A, M6202LL/A)Gossimer	241.98	119.98	59.99				
Power Mac G3 Series(M6142LL/A) Gossimer	241.98	119.98	59.99				

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NOTEBOOKS

The 300-MHz Front Line

Two issues ago, First Looks reviewed four of the first 300-MHz Pentium II portables to market, from Compaq, Dell, Hewlett-Packard, and Toshiba. According to our ZD Business Winstone benchmark test, these machines perform roughly 18 percent better than their 266-MHz counterparts under common Windows applications. Other vendors offering notebooks with Intel's latest and fastest mobile processor include Quantex, a direct seller out of New Jersey, and WinBook, a popular seller of value-priced notebooks based in Ohio.

Quantex Microsystems (800-346-6572, www.quantex.com) has incorporated the 300-MHz mobile Pentium II into its entire line of business notebooks, including the **H-Series** (targeted at road warriors) and two new lines—the **T-Series** (geared towards mobile professionals) and the **I-Series** (designed as desktop replacement).

The H-Series, of which a 266-MHz Pentium II offering was reviewed in our latest notebook feature story ("Traveling Powerhouses," August 1998), consist of 7-pound machines that offer two spindles (including a modular bay that can house a CD-ROM, a floppy disk drive, or a second battery). T-Series notebooks, designed for easier transport, weigh only 6 pounds (sans AC adapter) and are merely 1.45-inches thick.

Two separate 300-MHz T-Series models are currently available: the mainstream **T-1410** and the high-end **T-1411**. Each provides a 14.1-inch active matrix screen, a 6GB hard disk, a 128-bit PCI graphics

accelerator, a 56-Kbps fax modem, and Microsoft Office 97 Small Business Edition. Whereas the T-1410 (\$2,899 direct) ships with 80MB of SRAM, a separate 24X CD-ROM and a separate floppy disk drive (either of which can be used in the machine's lone modular bay), the T-1411 (\$3,199 direct) provides 96MB of SDRAM and a 2X DVD drive. In addition to the floppy disk drive, the T-1411 has a minidocking station and a second lithium ion battery. The latter can also be used in the machine's modular bay.

Larger in size, the I-Series offers a modular DVD drive and integrated AGP graphics (8MB of graphics memory). Like T-Series models, the **I-1411** (\$3,399 direct) is further equipped with a 14.1-inch active matrix display, a 6GB hard disk, a 56-Kbps fax modem, Microsoft Office 97 Small Business Edition, and a

modular floppy disk drive. The I-1411 is equipped with 128MB of SDRAM and accompanied by a second lithium ion battery and a minidocking station.

WinBook (800-254-7608, www.winbook.com)—which specializes in value notebooks (see below)—has added the 300-MHz Pentium to the existing **WinBook XLi** line and made the unit the foundation of the nascent **WinBook XL²**.

The **WinBook XLi 300** (\$2,999 direct), a three-spindle machine that integrates both a floppy disk drive and a 20X CD-ROM drive, offers WinBook's famous dual-pointing devices: a two-button touch pad and a pointing stick, which can be

used simultaneously. In addition to a 300-MHz Pentium II, its core specs include a 13.3-inch display, 64MB of RAM (expandable to 128MB), a PCI graphics accelerator with 4MB of SGRAM, a lithium ion battery, and a 6GB removable hard disk. WinBook even adds an NTSC TV out port for connecting to a standard television. Optional features include an in-



WinBook Breaks the \$1K Barrier

The \$999 notebook is here. In covering four sub-\$1,400s in our previous issue ("The New Bottom Line in Value," October 20, 1998), we predicted the imminent arrival of the sub-\$1,000 portable—but we didn't realize just how imminent that arrival was. On October 12, WinBook (800-254-7608, www.winbook.com), which had offered a \$1,199 WinBook XL all summer, introduced the \$999 WinBook XL, available for purchase only on the Web.

Like its \$1,199 predecessor, the new XL is a three-spindle machine equipped with a 20X CD-ROM and a standard floppy disk drive. Its 233-MHz MMX Pentium processor is surrounded by 256K of secondary cache, 16MB of RAM (expandable to 128MB), a 12.1-inch dual scan display, a PCI graphics accelerator (2MB of RAM), and a 1.6GB hard disk.

Unlike its predecessor, the \$999 machine uses a new PGA processor package meant to save a few dollars on cost. WinBook has further cut prices by selling the system only over the Web and by shipping all orders directly from the company's Taiwan manufacturer. The machine is also equipped with an NTSC video-out port, Zoomed video support, and MPEG support. Unlike many WinBook models, the XL lacks a second pointing device, offering only a dual-button touch pad. —Cade Metz



ternal modem (\$159 direct) and a port replicator (\$99 direct).

Just introduced this October, the XL² is a far more impressive machine. Priced only slightly higher (at \$3,199 direct) than the company's other offering, this three-spindle machine is but 1.5-inches thick and weighs 7 pounds—heretofore unheard of dimensions and weight for a portable machine equipped with both an LS-120 drive and a DVD-ROM drive.

The XL² also includes a 14.1-inch active matrix display, a 6GB removable hard disk, 128MB of SDRAM memory, 3-D graphics (ATI 3D Rage Pro LT with 4MB of graphics memory), 3D PCI audio, S-Video support, a lithium ion battery, and a 56-Kbps internal modem. As do most WinBook notebooks, the XL² offers both a pointing stick and a touchpad. For the benefit of large corporate customers—adheres to the latest Desktop Management Interface (DMI) and Wired for Management (WfM) specifications. As with the XLi, WinBook further equips the XL² with NTSC video-out. —Cade Metz

RECAP PC Magazine reviewed 54 notebooks in the issue of August 1998. Editors' Choice was awarded to the Gateway Solo 9100LS, NEC Versa LX, Gateway Solo 25SE, IBM ThinkPad 600, and IBM ThinkPad 560X.

GRAPHICS SOFTWARE

Automating Web Graphics

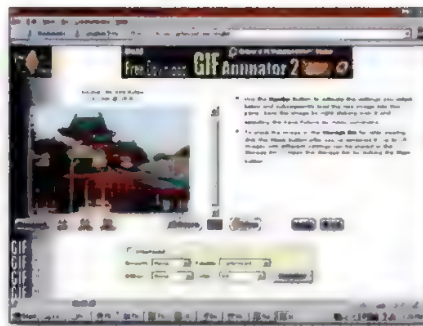
As Web designers come to need and expect more features and tools for developing their Web graphics, companies such as Adobe Systems (800-685-3663, www.adobe.com), MetaCreations Corp. (800-846-0111, www.metacreations.com), and Ulead Systems (800-858-5323, www.webutilities.com) are offering a wider range of integrated Web design tools than ever before.

Automation and ease of use are paramount to **Adobe ImageStyler 1.0** (\$130 street). ImageStyler uses the standard Adobe interface found in Photoshop and Illustrator. You start out working with shapes, images, and text. ImageStyler doesn't include any paint or drawing tools; rather, projects are built on imported images, text that's created using the text tool, and shapes that are inserted or created using a variety of shape-drawing tools.

After you lay out an image, effects (such as bevel and drop shadow) and styles can be placed on elements. All elements remain editable, and individual objects remain live. This means that if

you stylize one object and then replace it with another, the new object assumes the attributes that were already applied.

An *object style* consists of up to five layers of attributes (with a possible 100 attributes per layer)—including gradients, bevel,

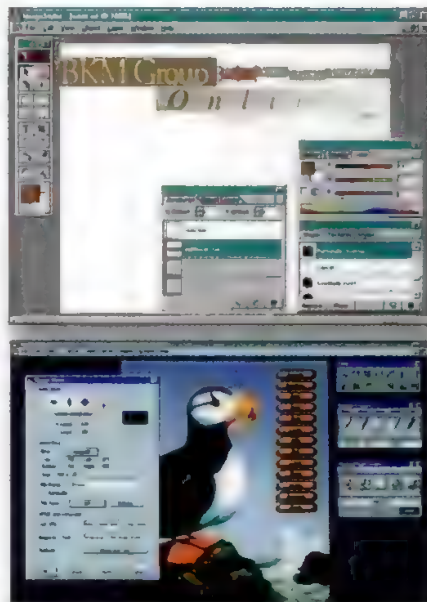


opacities, and user-customized styles—that can be assigned to an object at one time. With the graphical aliases, graphics in the same document can be associated, so when one graphic is edited, all of the associated graphics are automatically updated with the same changes. Attributes can be copied from one object and pasted to other objects.

To make Web pages more dynamic, ImageStyler can generate JavaScript rollovers and image maps. The program helps to optimize graphics, generating adaptive palettes for 8-bit images. The Active preview lets you view your optimized image as you alter settings in real time.

In a sense, ImageStyler can also work as a WYSIWYG Web

WEB IMAGING:
(clockwise from left)
Ulead
Graphics
Optimization
Toolkit, Adobe
ImageStyler,
Painter 5.5
Web Edition.



tool, as you can lay out graphics and then export them to table-based HTML, which will include the code for JavaScript rollovers and image maps. Meanwhile, upon export, ImageStyler can also automatically slice images for the best results and produce the HTML in order to reconstruct the image in the Web page.

Another useful batch-processing feature includes batch HTML replacement, which lets graphics be easily updated on the pages.

MetaCreations Painter 5.5 Web Edition (\$300 street; upgrade for Painter 5 users, \$80; upgrade price for Painter 4 users, \$130) takes MetaCreations' Painter—a program known for its unique natural-media brushes—and adds new features that will let Web designers create Web graphics and interfaces from within Painter.

Important additions in this incarnation of Painter include the ability to create client-side image maps, a new Dynamic Text Editor, and support for image slicing, which allows for faster downloads. When slicing an image, Painter automatically generates HTML, which can be placed in

your Web page to reconstruct the image properly. Painter can also be used to create GIF animations, transparent GIFs, and JavaScript rollover buttons.

Along with calligraphic and Web-safe brushes, Painter now

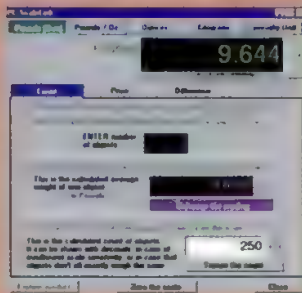
includes Web-safe color palettes, so you can freely create images without worrying about how they will look when viewed online. And for ease of use, Painter 5.5 also comes with hundreds of pre-designed buttons, textures, patterns, and images. Furthermore, Painter 5.5 provides support for the modified layer technology found in Adobe Photoshop 5.0.

Ulead takes its Web software niche to the next level with **Ulead Graphics Optimization Toolkit**. The goal of this free online service (www.webutilities.com) is to aid Web graphics designers who are creating Web-ready images. The image-optimization service offers functionality similar to that found in SmartSaver 3.0, Ulead's utility. Graphics Optimization Toolkit makes it easy for anyone to adjust resolution and image quality in order to produce Web-friendly GIF, JPEG, and PNG images. Simply upload the image you wish to reduce and choose from the various presets to achieve the best balance between quality and file size.—Matthew Graven

Your Own Postal Service

Do you find yourself stymied by the mere thought of standing on line at the post office just to find out how much a package is going to cost to mail? The U.S. Postal Service (800-843-8777, ext. 2113), in conjunction with software developer Window Book, is offering small businesses a solution: **The Postal Business Companion, Global Edition**.

This free software contains international and domestic postage-rate calculators, an interface with an electronic scale for weighing a package, and other tools that can help businesses calculate and track their mailing costs and increase productivity. For example, the mail-profits calculator lets you calculate the profit margin of a mailing prior to initiating the mailing. There's also a conversion calculator, an international clock and almanac, and a selection of small-business resources. Biweekly updates and Internet connectivity help keep your database of postal rates and information accurate and up-to-date.—Melissa J. Perenson





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THEY SAID THEY'VE SEEN YOUR KIND BEFORE.
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Processor	Intel® Celeron™ processor 300MHz	Intel Pentium® II processor 350MHz	Intel Pentium II processor 400MHz	Intel Pentium II processor 450MHz	Intel Pentium II processor 450MHz
Cache	128KB Internal L2 cache	512KB Internal L2 cache	512KB Internal L2 cache	512KB Internal L2 cache	512KB Internal L2 cache
RAM	32MB SDRAM	64MB 100MHz SDRAM	64MB 100MHz SDRAM	64MB 100MHz SDRAM	128MB 100MHz SDRAM
Hard Drive	4.3GB Ultra ATA hard drive	10GB Ultra ATA hard drive	10GB Ultra ATA hard drive	10GB Ultra ATA hard drive	14.4GB 7200 RPM Ultra ATA hard drive
Monitor	15" Micron 500Vx monitor (13.8" display)	17" Micron 700Vx monitor (15.9" display)	17" Micron 700Vx monitor (15.9" display)	17" Micron 700Vx monitor (15.9" display)	19" Micron 900Lx monitor (16" display)
DVD/CD-ROM	32X max speed CD-ROM drive	32X max speed CD-ROM drive	32X max speed CD-ROM drive	32X max speed CD-ROM drive	DVD-ROM drive and decoder card***
Modem	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**
Graphics	nVidia Riva 128, 4MB SGRAM 3D AGP graphics	nVidia Riva 128, 8MB SGRAM 3D AGP graphics	nVidia Riva 128, 8MB SGRAM 3D AGP graphics	nVidia Riva 128, 8MB SGRAM 3D AGP graphics	Real 3D Starfighter 740, 8MB AGP graphics
Sound System	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound
Warranty	5-year/3-year Micron Power™ limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty
Software Included	Microsoft® Windows® 98 Microsoft Home Essentials Microsoft Power Pak Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus
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Price	\$1,199 \$42/mo. TechRefresh Bus. Lease, 36 mos.**	\$1,649 \$58/mo. TechRefresh Bus. Lease, 36 mos.**	\$1,749 \$61/mo. TechRefresh Bus. Lease, 36 mos.**	\$1,799 \$63/mo. TechRefresh Bus. Lease, 36 mos.** <i>New Low Price!</i>	\$2,899 \$101/mo. TechRefresh Bus. Lease, 36 mos.** <i>New Low Price!</i>
Upgrade to:	6.4GB Ultra ATA hard drive 17" Micron 700Vx monitor (15.9" display) 100MB Imago Zip drive	13.6GB Ultra ATA hard drive 19" Micron 900Lx (16" display) 100MB Imago Zip drive	13.6GB Ultra ATA hard drive 19" Micron 900Lx (16" display) 100MB Imago Zip drive	13.6GB Ultra ATA hard drive 19" Micron 900Lx (16" display) 100MB Imago Zip drive	256MB 100MHz SDRAM Microsoft Natural Keyboard Elite
Price	\$1,426 \$50/mo. TechRefresh Bus. Lease, 36 mos.**	\$1,996 \$70/mo. TechRefresh Bus. Lease, 36 mos.**	\$2,096 \$73/mo. TechRefresh Bus. Lease, 36 mos.**	\$2,196 \$77/mo. TechRefresh Bus. Lease, 36 mos.** <i>New Low Price!</i>	\$3,214 \$112/mo. TechRefresh Bus. Lease, 36 mos.** <i>New Low Price!</i>



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—William Goins, III



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Model Name

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TREK² 233

TREK² 266

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Processor	Intel® Pentium® II processor 233MHz	Intel Pentium II processor 233MHz	Intel Pentium II processor 266MHz	Intel Pentium II processor 300MHz
Cache	512KB L2 pipeline burst cache	512KB L2 pipeline burst cache	512KB L2 pipeline burst cache	512KB L2 pipeline burst cache
RAM	32MB SDRAM	64MB SDRAM	64MB SDRAM	64MB SDRAM
Hard Drive	3.2GB hard drive	3.2GB hard drive (removable)	3.2GB hard drive (removable)	3.2GB hard drive (removable)
Monitor	12.1" SVGA TFT display	14.1" XGA TFT display	14.1" XGA TFT display	14.1" XGA TFT display
Extra Storage	3.5" floppy disk drive	3.5" floppy disk drive (dedicated bay)	3.5" floppy disk drive (dedicated bay)	3.5" floppy disk drive (dedicated bay)
CD-ROM	24X CD-ROM drive	24X CD-ROM drive (dedicated bay)	24X CD-ROM drive (dedicated bay)	24X CD-ROM drive (dedicated bay)
Graphics	4MB AGP graphics accelerator	4MB AGP graphics accelerator	4MB AGP graphics accelerator	4MB AGP graphics accelerator
Sound System	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone
Warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty

Software Included	Microsoft® Windows® 98 System Wizard Mobile Client™ Norton AntiVirus	Microsoft Windows 98 Microsoft Office Small Business Edition System Wizard Mobile Client™ Norton AntiVirus	Microsoft Windows 98 Microsoft Office Small Business Edition System Wizard Mobile Client™ Norton AntiVirus	Microsoft Windows 98 Microsoft Office Small Business Edition System Wizard Mobile Client™ Norton AntiVirus
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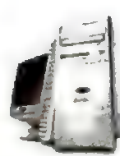
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OBSOLESCENCE PROTECTION

3. Other computer companies make you wait 2 to 4 years in their upgrade programs before you can trade up, and many hold you to restrictive finance agreements. With Micron you're eligible to upgrade a system anytime from 12 to 48 months after purchase, regardless of how you finance your purchase. Plus, you can send us your old machines for wholesale trade-in rebates which apply towards the purchase of new machines.

CUSTOM CONFIGURATION

4. Some manufacturers force you to purchase pre-selected software packages to qualify for their programs. Not Micron. We offer unparalleled hardware and software flexibility with all our custom-configured machines.

MICRON ANNOUNCES BREAKTHROUGH PRICING ON AWARD-WINNING SYSTEMS

Model Name	Millennia® C300	Millennia 350	Millennia 400	New! Millennia 450	New! Millennia 450 MAX
Processor	Intel® Celeron™ processor 300MHz	Intel Pentium® II processor 350MHz	Intel Pentium II processor 400MHz	Intel Pentium II processor 450MHz	Intel Pentium II processor 450MHz
Cache	128KB internal L2 cache	512KB internal L2 cache	512KB internal L2 cache	512KB internal L2 cache	512KB internal L2 cache
RAM	32MB SDRAM	64MB 100MHz SDRAM	64MB 100MHz SDRAM	64MB 100MHz SDRAM	128MB 100MHz SDRAM
Hard Drive	4.3GB Ultra ATA hard drive	8GB Ultra ATA hard drive	10GB Ultra ATA hard drive	10GB Ultra ATA hard drive	14.4GB 7200 RPM Ultra ATA hard drive
Monitor	15" Micron 700Vx monitor (15.8" display)	17" Micron 700Vx monitor (15.8" display)	17" Micron 700Vx monitor (15.8" display)	17" Micron 700Vx monitor (15.8" display)	19" Micron 900Vx monitor (18" display)
DVD/CD-ROM	32X max speed CD-ROM drive	32X max speed CD-ROM drive	32X max speed CD-ROM drive	32X max speed CD-ROM drive	DVD-ROM drive and decoder card***
Modem	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**
Graphics	nVidia Riva 128, 4MB SDRAM 3D AGP graphics	nVidia Riva 128, 4MB SDRAM 3D AGP graphics	nVidia Riva 128, 4MB SDRAM 3D AGP graphics	nVidia Riva 128, 4MB SDRAM 3D AGP graphics	Real 3D StarFighter 1240, 4MB AGP graphics
Sound System	PCI 64-voice WaveTable sound	PCI 64-voice WaveTable sound	PCI 64-voice WaveTable sound	PCI 64-voice WaveTable sound	PCI 64-voice WaveTable sound
Warranty	5-year/3-year Micron Power Limited warranty	5-year/3-year Micron Power Limited warranty	5-year/3-year Micron Power Limited warranty	5-year/3-year Micron Power Limited warranty	5-year/3-year Micron Power Limited warranty

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Replace your desktop with the Micron TransPort TREK



Model Name	TREK™ 266	New! TREK™ 300	GoBook™ 233	GoBook™ 266	New! GoBook™ 300
Processor	Intel Pentium II processor 266MHz	Intel Pentium II processor 300MHz	Intel Pentium processor with MMX technology 233MHz	Intel Pentium II processor 266MHz	Intel Pentium II processor 300MHz
Cache	32KB L2 pipeline burst cache	32KB L2 pipeline burst cache	32KB L2 pipeline burst cache	32KB L2 pipeline burst cache	32KB L2 pipeline burst cache
RAM	64MB SDRAM	64MB SDRAM	32MB EDO RAM	32MB EDO RAM	32MB EDO SDRAM
Hard Drive	3.2GB hard disk drive (removable)	3.2GB hard disk drive (removable)	2.5GB hard drive	3.2GB hard disk drive	3.2GB hard disk drive (removable)
Monitor	14.1" VGA TFT display	14.1" VGA TFT display	12.1" SVGA TFT display	12.1" SVGA TFT display	12.1" SVGA TFT display
DVD/CD-ROM	24X CD-ROM (dedicated bay)	24X CD-ROM (dedicated bay)	24X modular CD-ROM drive	24X modular CD-ROM	24X CD-ROM (dedicated bay)
Graphics	4MB AGP graphics accelerator	4MB AGP graphics accelerator	2MB/128-bit graphics accelerator	2MB/128-bit graphics accelerator	2MB/128-bit graphics accelerator
Sound System	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone	16-bit stereo/WaveTable sound	16-bit stereo/WaveTable sound	16-bit stereo/WaveTable sound
Warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty
Upgrades	128MB SDRAM for \$199	128MB SDRAM for \$199	Add SuperDisk battery for \$299	Add SuperDisk battery for \$299	Add SuperDisk battery for \$299

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FULLY-FEATURED 21" (19.7" DVI*) MONITOR LINE

21" Models	CRT Pitch	Max. Resolution	Auto-Sum Range
Diamond Plus 100e	0.28 mm	1600 x 1200/85 Hz NI	H: 30-115 kHz V: 50-152 Hz
Diamond Pro 91TXM	0.26 mm	1600 x 1200/75 Hz NI	H: 30-95 kHz V: 50-152 Hz
Diamond Pro 1010e	0.26 mm	1800 x 1440/76 Hz NI	H: 30-115 kHz V: 50-152 Hz
Diamond Pro 1000	0.28 mm	1800 x 1440/76 Hz NI	H: 30-115 kHz V: 50-152 Hz

* DVI: Diagonal Viewable Image. Resolution refers to maximum addressable resolution H x V.

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OS: Microsoft Windows 95/98/NT/2000, Mac OS 7.5/8.5/9.0/9.1/9.2/9.3/9.4/9.5/9.6/9.7/9.8/9.9/10.0/10.1/10.2/10.3/10.4/10.5/10.6/10.7/10.8/10.9/11.0/11.1/11.2/11.3/11.4/11.5/11.6/11.7/11.8/11.9/12.0/12.1/12.2/12.3/12.4/12.5/12.6/12.7/12.8/12.9/13.0/13.1/13.2/13.3/13.4/13.5/13.6/13.7/13.8/13.9/14.0/14.1/14.2/14.3/14.4/14.5/14.6/14.7/14.8/14.9/15.0/15.1/15.2/15.3/15.4/15.5/15.6/15.7/15.8/15.9/16.0/16.1/16.2/16.3/16.4/16.5/16.6/16.7/16.8/16.9/17.0/17.1/17.2/17.3/17.4/17.5/17.6/17.7/17.8/17.9/18.0/18.1/18.2/18.3/18.4/18.5/18.6/18.7/18.8/18.9/19.0/19.1/19.2/19.3/19.4/19.5/19.6/19.7/19.8/19.9/20.0/20.1/20.2/20.3/20.4/20.5/20.6/20.7/20.8/20.9/21.0/21.1/21.2/21.3/21.4/21.5/21.6/21.7/21.8/21.9/22.0/22.1/22.2/22.3/22.4/22.5/22.6/22.7/22.8/22.9/23.0/23.1/23.2/23.3/23.4/23.5/23.6/23.7/23.8/23.9/24.0/24.1/24.2/24.3/24.4/24.5/24.6/24.7/24.8/24.9/25.0/25.1/25.2/25.3/25.4/25.5/25.6/25.7/25.8/25.9/26.0/26.1/26.2/26.3/26.4/26.5/26.6/26.7/26.8/26.9/27.0/27.1/27.2/27.3/27.4/27.5/27.6/27.7/27.8/27.9/28.0/28.1/28.2/28.3/28.4/28.5/28.6/28.7/28.8/28.9/29.0/29.1/29.2/29.3/29.4/29.5/29.6/29.7/29.8/29.9/30.0/30.1/30.2/30.3/30.4/30.5/30.6/30.7/30.8/30.9/31.0/31.1/31.2/31.3/31.4/31.5/31.6/31.7/31.8/31.9/32.0/32.1/32.2/32.3/32.4/32.5/32.6/32.7/32.8/32.9/33.0/33.1/33.2/33.3/33.4/33.5/33.6/33.7/33.8/33.9/34.0/34.1/34.2/34.3/34.4/34.5/34.6/34.7/34.8/34.9/35.0/35.1/35.2/35.3/35.4/35.5/35.6/35.7/35.8/35.9/36.0/36.1/36.2/36.3/36.4/36.5/36.6/36.7/36.8/36.9/37.0/37.1/37.2/37.3/37.4/37.5/37.6/37.7/37.8/37.9/38.0/38.1/38.2/38.3/38.4/38.5/38.6/38.7/38.8/38.9/39.0/39.1/39.2/39.3/39.4/39.5/39.6/39.7/39.8/39.9/40.0/40.1/40.2/40.3/40.4/40.5/40.6/40.7/40.8/40.9/41.0/41.1/41.2/41.3/41.4/41.5/41.6/41.7/41.8/41.9/42.0/42.1/42.2/42.3/42.4/42.5/42.6/42.7/42.8/42.9/43.0/43.1/43.2/43.3/43.4/43.5/43.6/43.7/43.8/43.9/44.0/44.1/44.2/44.3/44.4/44.5/44.6/44.7/44.8/44.9/45.0/45.1/45.2/45.3/45.4/45.5/45.6/45.7/45.8/45.9/46.0/46.1/46.2/46.3/46.4/46.5/46.6/46.7/46.8/46.9/47.0/47.1/47.2/47.3/47.4/47.5/47.6/47.7/47.8/47.9/48.0/48.1/48.2/48.3/48.4/48.5/48.6/48.7/48.8/48.9/49.0/49.1/49.2/49.3/49.4/49.5/49.6/49.7/49.8/49.9/50.0/50.1/50.2/50.3/50.4/50.5/50.6/50.7/50.8/50.9/51.0/51.1/51.2/51.3/51.4/51.5/51.6/51.7/51.8/51.9/52.0/52.1/52.2/52.3/52.4/52.5/52.6/52.7/52.8/52.9/53.0/53.1/53.2/53.3/53.4/53.5/53.6/53.7/53.8/53.9/54.0/54.1/54.2/54.3/54.4/54.5/54.6/54.7/54.8/54.9/55.0/55.1/55.2/55.3/55.4/55.5/55.6/55.7/55.8/55.9/56.0/56.1/56.2/56.3/56.4/56.5/56.6/56.7/56.8/56.9/57.0/57.1/57.2/57.3/57.4/57.5/57.6/57.7/57.8/57.9/58.0/58.1/58.2/58.3/58.4/58.5/58.6/58.7/58.8/58.9/59.0/59.1/59.2/59.3/59.4/59.5/59.6/59.7/59.8/59.9/60.0/60.1/60.2/60.3/60.4/60.5/60.6/60.7/60.8/60.9/61.0/61.1/61.2/61.3/61.4/61.5/61.6/61.7/61.8/61.9/62.0/62.1/62.2/62.3/62.4/62.5/62.6/62.7/62.8/62.9/63.0/63.1/63.2/63.3/63.4/63.5/63.6/63.7/63.8/63.9/64.0/64.1/64.2/64.3/64.4/64.5/64.6/64.7/64.8/64.9/65.0/65.1/65.2/65.3/65.4/65.5/65.6/65.7/65.8/65.9/66.0/66.1/66.2/66.3/66.4/66.5/66.6/66.7/66.8/66.9/67.0/67.1/67.2/67.3/67.4/67.5/67.6/67.7/67.8/67.9/68.0/68.1/68.2/68.3/68.4/68.5/68.6/68.7/68.8/68.9/69.0/69.1/69.2/69.3/69.4/69.5/69.6/69.7/69.8/69.9/70.0/70.1/70.2/70.3/70.4/70.5/70.6/70.7/70.8/70.9/71.0/71.1/71.2/71.3/71.4/71.5/71.6/71.7/71.8/71.9/72.0/72.1/72.2/72.3/72.4/72.5/72.6/72.7/72.8/72.9/73.0/73.1/73.2/73.3/73.4/73.5/73.6/73.7/73.8/73.9/74.0/74.1/74.2/74.3/74.4/74.5/74.6/74.7/74.8/74.9/75.0/75.1/75.2/75.3/75.4/75.5/75.6/75.7/75.8/75.9/76.0/76.1/76.2/76.3/76.4/76.5/76.6/76.7/76.8/76.9/77.0/77.1/77.2/77.3/77.4/77.5/77.6/77.7/77.8/77.9/78.0/78.1/78.2/78.3/78.4/78.5/78.6/78.7/78.8/78.9/79.0/79.1/79.2/79.3/79.4/79.5/79.6/79.7/79.8/79.9/80.0/80.1/80.2/80.3/80.4/80.5/80.6/80.7/80.8/80.9/81.0/81.1/81.2/81.3/81.4/81.5/81.6/81.7/81.8/81.9/82.0/82.1/82.2/82.3/82.4/82.5/82.6/82.7/82.8/82.9/83.0/83.1/83.2/83.3/83.4/83.5/83.6/83.7/83.8/83.9/84.0/84.1/84.2/84.3/84.4/84.5/84.6/84.7/84.8/84.9/85.0/85.1/85.2/85.3/85.4/85.5/85.6/85.7/85.8/85.9/86.0/86.1/86.2/86.3/86.4/86.5/86.6/86.7/86.8/86.9/87.0/87.1/87.2/87.3/87.4/87.5/87.6/87.7/87.8/87.9/88.0/88.1/88.2/88.3/88.4/88.5/88.6/88.7/88.8/88.9/89.0/89.1/89.2/89.3/89.4/89.5/89.6/89.7/89.8/89.9/90.0/90.1/90.2/90.3/90.4/90.5/90.6/90.7/90.8/90.9/91.0/91.1/91.2/91.3/91.4/91.5/91.6/91.7/91.8/91.9/92.0/92.1/92.2/92.3/92.4/92.5/92.6/92.7/92.8/92.9/93.0/93.1/93.2/93.3/93.4/93.5/93.6/93.7/93.8/93.9/94.0/94.1/94.2/94.3/94.4/94.5/94.6/94.7/94.8/94.9/95.0/95.1/95.2/95.3/95.4/95.5/95.6/95.7/95.8/95.9/96.0/96.1/96.2/96.3/96.4/96.5/96.6/96.7/96.8/96.9/97.0/97.1/97.2/97.3/97.4/97.5/97.6/97.7/97.8/97.9/98.0/98.1/98.2/98.3/98.4/98.5/98.6/98.7/98.8/98.9/99.0/99.1/99.2/99.3/99.4/99.5/99.6/99.7/99.8/99.9/100.0/100.1/100.2/100.3/100.4/100.5/100.6/100.7/100.8/100.9/101.0/101.1/101.2/101.3/101.4/101.5/101.6/101.7/101.8/101.9/102.0/102.1/102.2/102.3/102.4/102.5/102.6/102.7/102.8/102.9/103.0/103.1/103.2/103.3/103.4/103.5/103.6/103.7/103.8/103.9/104.0/104.1/104.2/104.3/104.4/104.5/104.6/104.7/104.8/104.9/105.0/105.1/105.2/105.3/105.4/105.5/105.6/105.7/105.8/105.9/106.0/106.1/106.2/106.3/106.4/106.5/106.6/106.7/106.8/106.9/107.0/107.1/107.2/107.3/107.4/10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Trends Peripherals

SOUND CARDS

PC Sound Showdown

Thanks to the latest 3-D sound APIs (application programming interfaces) for Windows 95 and 98, game developers are finally abandoning the DOS

environment once and for all. Windows-based games are now coming into their own, and sound technology is starting to advance at the same breakneck pace as 3-D graphics, leaving mere Sound Blaster compatibility outdated. The field is wide open for a new de facto PC sound standard, and the front-runners are Aureal Semiconductor's A3D, Creative Labs' EAX, Microsoft's

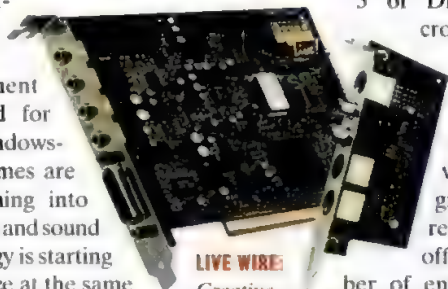
own DirectSound 3D, and QSound Surround from QSound Labs.

Last year, DirectSound 3D was first bundled into Version 5 of DirectX, Microsoft's multi-

media API. Windows currently ships with the upgraded DirectX 6, which offers a num-

ber of enhancements and is supported by virtually all current sound cards. The three competing APIs overlay DirectSound 3D and further enhance its capabilities. Both

of these APIs require special hardware in the form of on-board chips to produce the ex-



LIVE WIRE: Creative Labs' latest Sound Blaster cards.

panded sound for which they're designed.

New from Creative Labs (800-998-1000, www.sblive.com) comes the **Creative Sound Blaster Live!** card (\$200 street), as well as its companion, the **Creative Sound Blaster Live! Value** (\$100 street). Built around the company's EAX (Environmental Audio Extensions) API, each card produces enhanced 3-D sound from two or more speakers—including Creative Labs' own speaker sets, which are designed for the company by Cambridge Soundworks (800-367-

4434, www.hifi.com), a Creative Labs subsidiary.

Diamond Multimedia Systems offers the **Diamond Monster Sound MX300** audio accelerator (\$100 street), which is built around the new Vortex 2 processor from Aureal Semiconductor (800-468-5846, www.diamondmm.com). The processor supports Microsoft's DirectSound 3D as well as the newest version of Aureal's own API, A3D 2.0. The Vortex 2 includes Aureal's own hardware-based wave-tracing engine for wall reflections and occlusions. —Josh Levy

MASS STORAGE

Hot-Swappable IDE Drives

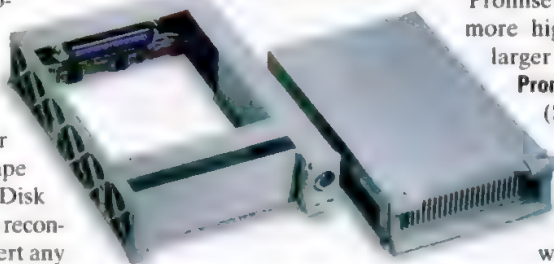
Taking work home with you just took on a whole new meaning, thanks to a set of new products from Hi-Val (714-953-3000, www.hival.com) and Promise Technology (800-888-0245, www.promise.com). These cartridge devices allow you to install and remove IDE storage peripherals on the fly—without having to reboot.

The **Hi-Val HotDocking Module**, priced at \$50 for the first unit and \$40 for each additional unit (street prices), was designed in partnership with software developer Agaté Technologies (800-982-4283, www.agatetech.com). The module fits into a standard 5.25-inch bay, allowing you to remove your hard disk, Zip Drive, tape drive, or LS-120 SuperDisk drive without rebooting or reconfiguring your PC. Just insert any

3.5-inch IDE storage device into the cartridge and slide the cartridge into the bay until the embedded drive plugs in to the rear connector.

Besides the convenience of portability, the HotDocking Module can be used as a security device, letting you remove sensitive data from PCs easily accessible to intruders (such as the one in your office's front lobby). Hot-swapping also eases repair and maintenance by letting you

TAKE IT WITH YOU: The Promise FastSwap Pro.



remove and replace defective devices on the fly, without opening the case. Each HotDocking Module comes with a lock to prevent unwanted removal; there's also a built-in cooling fan and LEDs that indicate disk activity.

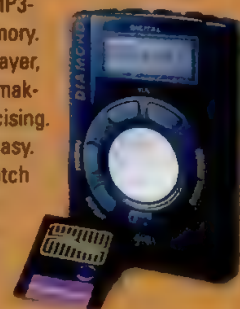
Promise Technology offers a more high-end solution for larger office settings. The **Promise FastSwap Pro** (\$349 list) kit includes two FastSwap chassis (each \$129 list when purchased individually), along with dedicated cooling

fans and security locks, plus the Promise FastTrak IDE RAID controller card. The card includes two IDE channels, each of which can support two hard disks. You can structure each pair of disks in a RAID 1 configuration for data redundancy or in a RAID 0 configuration for striping (to improve performance). Most appealing for small business users: If you're set up with RAID 1, whenever a disk fails, just remove it from the FastSwap bay and replace it on the fly. All of your data will still be available to you from the other disk. —Adam Asch

Move Over, MiniDisc

The personal stereo meets the PC age—only it's not Sony that's leading the way. Instead, look toward Diamond Multimedia (408-325-7000, www.diamondmm.com), which has released the **Rio PMP300** portable music player (\$199.95 list). Smaller than a cigarette pack and weighing just 2.4 ounces, the Rio can store an hour of MP3-encoded digital music in its internal flash memory. Unlike a portable cassette, CD, or MiniDisc player, the Rio has no moving parts and never skips, making it ideal to use when biking, hiking, or exercising.

Getting your favorite music into the Rio is easy. The included Jukebox software (by MusicMatch and Xing Technology) lets you convert tracks from audio CDs placed in your CD-ROM drive to MP3 format. Or you can download already encoded songs from licensed sites such as mp3.com or goodnoise.com (typical cost is about 75 cents per song). Then simply attach the Rio to your PC's parallel port and download your custom mix. The memory is rewritable, so you can change the player's content at any time. There's even a built-in SmartMedia memory card reader, so you can store more songs on the miniature cards (\$49 for 30 minutes, \$99 for 1 hour) and take them with you. —Jamie M. Bsates



HEALTH WEB SITES

Where Does it Hurt?

Whether you want to know if creatine or androstenedione will help you build muscles like a professional athlete or if you're looking for a natural way to combat seasonal allergies, these up-and-coming Web sites can be valuable resources for your health and nutritional needs. Some sites are designed to be purely informational, while others also sell discounted supplements and health products.

Former U.S. Surgeon General C. Everett Koop's Empower Health Corporation recently launched **Dr. Koop's Community** (www.drkoop.com), a Web site divided into two main sections—one that provides health resources and the other with interactive community features. The site is designed to help visitors make better health care decisions.

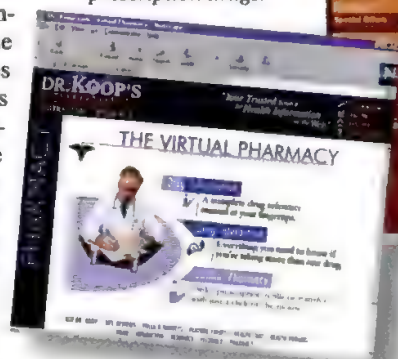
The Resource section has channels that cover subjects such as children's, women's, and men's health. The section's Virtual Pharmacy has a Web-based interactive system that lets you look up the reactions and interactions between multiple drugs—both over the counter and prescription.

The Interactive section offers health forums and chats that let visitors interact with others online and discuss health-related topics. The section will also soon feature medical experts and other guest speakers.

VitaSave (www.vitasave.com) is in the business of selling discounted vitamins, minerals, herbs, sports nutrition, health and beauty aids, and related books, but the Web site also offers information about the products it sells.

VitaSave has more than 6,000 items, and online purchases are received within two to five business days. The site's reference information is divided into categories such as Weight Lifting, HIV/AIDS, Hypertension, Meno-

HEALTH NEWS: Find new workout techniques or learn about your prescription drugs.

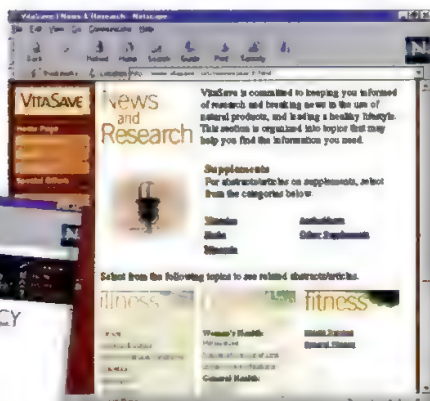


pause, and other health, illness, and fitness topics.

Another online store that also doubles as a source for health and nutrition information is **GreenTree Nutrition** (www.greentree.com). The site's Library provides information on subjects such as Nutrients and Supplements, Body and Health Conditions, and Your Diet. The information comes from many different sources, including the site's licensed content from *The New England Journal of Medicine*, *Time-Life*, *MedLine*, and *The New York Times Syndicate*.

There's also a search engine for products, a feature product that is regularly updated, and a shopping list of Top Products.

Fuisz Technologies, a company that develops and manufactures drug and other products,



offers **Fuisz Drug Store** (www.fuiszdrugstore.com), an online store and information resource. The site is organized into subject areas such as Medicine Cabinet, Nutrition and Diet Aids, and Mouth Care. Click on a category and you see related Fuisz products. Click on a specific product and get more information about it as well as the price. Then, you may order the product online if you wish. The site is adding a section called **Mirkin's Corner**, which will include information from nationally syndicated radio host Dr. Gabe Mirkin.

—Doug Beizer

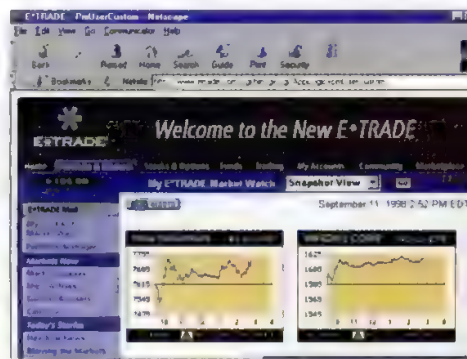
WEB SITE PRODUCTION

Graphics Generator

Keeping a Web site's content from becoming stale can be a labor-intensive endeavor. Helping ease the path is **Macromedia Generator**, a package which automates the creation of dynamic graphic elements for the Web.

Macromedia's latest (800-326-2128, www.macromedia.com) tool uses templates created in Flash 3, Macromedia's popular program for crafting streaming media, to make Web graphics on the fly with dynamic data. Generator automatically queries any SQL or ODBC/JDBC-compliant data-

base and builds graphics, movies, or other dynamic elements based on the updated database. The pro-



UPDATE: E*Trade's site uses Generator.

Connect for Less

With the kids away at school and your family scattered around the country, your telephone bills might be starting to frighten you. Avoiding those high long-distance rates becomes easier with the e-Net (888-366-3638, www.enetconnect.com) **NetConnect** (\$149 list), a full duplex audio card that lets you use your regular phone over the Internet.

Working with your 28.8-Kbps or better modem, NetConnect lets you call other people online—PC to PC—with the provided Microsoft NetMeeting software. The people you call do not need a NetConnect card as long as they use NetMeeting or a similar telephony software application. You can also hop off the Internet and call someone using the included Net2Phone software by IDT Corp., a special service provider. Voice quality is dependent on your connection speed and the amount of traffic over the Internet.—Adam Asch

gram works with standard Web graphics formats, such as GIF, JPEG, PNG, SWF, and vector-based Flash files. Generator can also personalize the graphic element to reflect either the surfer's preferences or up-to-the-minute information, enabling developers to create sites high in graphics and low in maintenance, such as dynamic headline tickers with the latest news about your company.

There are both standalone and server versions available—Generator Developer's Studio, Flash Edition (\$499 list) per user license, and Generator Dynamic Graphics Server (\$2,999 list) per server processor.—Jeremy A. Kaplan

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Trends Networking

V.90 MODEMS

The Final Standard

Since the 56K modem standard debuted last year, buying a modem has been an exercise in confusion. The industry split into two proprietary camps: X2 and K56flex. Although the faster speeds were welcome, if your ISP didn't support your modem's technology, the connection bounced back to 33.6 Kbps.

The two sides came together to make a 56K equivalent of the V.34 standard: The ITU's V.90 standard was agreed upon earlier this year, and most companies rushed to provide compliance. The V.90 spec was preliminary at that point, however, and final modem firmware was not available until September. Early adopters could find themselves with a high-speed modem they couldn't use. Unless a user had a dual-mode proprietary/V.90 modem, he or she could be limited to a connection of 33.6 Kbps, because few ISPs had yet to adopt V.90. (See our Second Looks section for users' experiences with early V.90 code.)

Now that the final V.90 spec is out and modem makers are shipping final firmware, the confusion is over for modem buyers. Modem vendors are issuing final V.90 flash upgrades for products they have already sold, and their current modem lines are being upgraded to the final code. There's also a new generation of modems that include final V.90 code native in the units, usually along with one of the proprietary 56K standards—at least until V.90 back ends at ISPs become more common.

Diamond Multimedia (800-486-5846, www.diamondmm.com) has a new V.90 native, PCI version of its **SupraSonic II** dual-line modem. The SupraSonic II uses Diamond's Shotgun technology to combine the bandwidth of two V.90/F56flex connection to achieve speeds of up to 112 Kbps. When an incoming voice call comes in over one of the

lines, the SupraSonic drops one of the data lines and lets you answer the call. Due out this season, pricing was not available at press time.

Multitech (800-328-9717, www.multitech.com) has two new V.90 offerings. The **MultiModemZPX-PCI** (\$200 street) is an internal modem based on a Lucent chip set. The ZPX-PCI includes both V.90 and K56flex data transfer and up to 14.4 Kbps for fax transfer. The modem features auto-speed conversion and comes bundled with Microsoft Windows data communications software.

The **Multitech Message Saver** (\$200 street) is an all-in-one voice- and data-transfer solution. In addition to being a V.90/K56flex modem, the Message Saver includes a full-function software-based answering machine with a built-in speaker phone. The device also operates as a fax server for your PC, sending out faxes at up to 14.4 Kbps and auto-detecting and storing faxes so you don't have to leave your PC on in order to receive incoming transmissions.

Compaq's (800-345-1442, www.compaq.com) Client Access Business Unit is releasing two new business-oriented V.90 modems. The **Compaq 56K PCI Fax Modem** is an internal modem with standard K56flex



and V.90 capabilities. The **Compaq 56K USB Fax Modem** is an external USB-compliant modem. As with any USB appliance, it offers hot-plug capability. The Compaq also has a V.90 status light that lets you know if you're connecting with V.90 or K56flex. Both modems feature Universal DAA, which means they are approved for use in multiple countries, so international organizations standardize on one modem. Also due out this season, pricing for both units was not available at press time.

NewCom's (818-597-3200, www.newcomminc.com) first V.90 modem is the **56K efxsp V.90** (\$109 list). The efxsp is an external



THE V.90 ERA IS HERE:
New 56K modems adhering to the V.90 standard.



modem featuring a full-duplex speakerphone, V.90/K56flex data transfer, 14.4-Kbps fax capabilities, and support for V.80 POTS video-conferencing. The unit comes bundled with Microsoft Internet Explorer 4.0, ViruSafe 95, and Trio Communications Suite.—*Michael N. Rusignuolo*

RECAP We looked at early V.90 implementation in our August 1998 story on PC Card modems. The 3Com Megahertz 56K Global Modem PC Card won our Editors' Choice.

PRINT SERVERS

Internet Printing

The latest in Hewlett-Packard's (916-785-1552, www.hp.com) line of print servers, the **HP JetDirect 500X** (\$319 list; \$459 list with Token Ring) introduces a new trick: printing over the Internet. In addition to being a regular three-part print server working with any company's printers, the

500X extends the range of your network by letting users send documents from a PC to print on any Internet-connected printer. Network users can thus bypass faxing or e-mailing documents, and you can deliver proofs to your printing bureau without leaving the office.

The 500X achieves this functionality with the Internet Printing Protocol (IPP), which Hewlett-Packard developed in conjunction with Microsoft. Users can select any IPP-capable printer they have access

rights to and print to it as they would any other local printer. In the past, print servers could not support multifunction printer devices. The 500X is the first print server to do so.

The package includes the new version of HP's printer management software, **HP Web JetAdmin 5.0**. Web JetAdmin 5.0 lets you set early alert parameters for things such as paper and toner levels and integrates with larger network management programs.

JetAdmin 5.0 also provides a built-in download feature that makes it easier for administrators to upgrade print server firmware. The software works on Microsoft Windows 95 and 98, as well as on Windows NT, Novell Netware, OS/2 Warp, and Unix.—*Carol Mangis*





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VisionMaster 502 (19.5" VIS)	TCO '95	0.27mm/dp	110khz	1800 x 1440@74hz	\$999
VisionMaster 501 (19.5" VIS)	TCO '95	0.27mm/dp	96khz	1600 x 1200@75hz	\$939
19" VisionMaster Pro 450 (18.0" VIS)	TCO '95	0.25mm/AG	102khz	1600 x 1200@80hz	\$699
VisionMaster 450 (18.0" VIS)	TCO '95	0.26mm/dp	102khz	1600 x 1200@80hz	\$659
17" VisionMaster Pro 400 (16.0" VIS)	TCO '95	0.25mm/AG	96khz	1600 x 1200@75hz	\$498
VisionMaster 400 (16.0" VIS)	TCO '95	0.26mm/dp	96khz	1600 x 1200@75hz	\$459
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15" Pro Lite 38a (with OSD)	TCO '95	0.279mm	62.5khz	1024 x 768@75hz	\$1,129
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Performance & Technical Excellence
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April 1997, May 1997, June 1997
VisionMaster Pro 21



October 7, 1997
VisionMaster Pro 17



March 1997
VisionMaster Pro 21



Twelve Time Winner
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Sept 1997, Jan 1998, March 1998,
May 1998, July 1998, Sept 1998
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First Looks



Novell's NetWare Turns 5

The newest version of Novell's NetWare strives to broaden its scope and stay ahead of the competition. We test the new NOS against its predecessor and Windows NT.

By Steve Rigney

To win the title of server platform of choice, Novell must concentrate on *all* of the functions that make up a network operating system—and not just the file and print services that its flagship NetWare is so well known for. NetWare 5 is Novell's best attempt yet at offering comprehensive network services, and we think it does an excellent job.

No longer should you think of NetWare as merely a great file and print NOS: Now, you can use it to run server-based applications, manage all of your client PCs, keep track of every system and user on the network, set up a corporate intranet, and reduce your network's total cost of ownership. As welcome as these additions may be, it remains to be seen whether Novell can use the year or so before Microsoft Win-

dows NT Server 5.0 ships to win back some market share.

NEW AND IMPROVED

Many of the improvements in NetWare 5 involve changes to the actual kernel, which the user will never see. For example, NetWare 5 uses a virtual memory scheme that allows the OS to utilize hard disk space as RAM. In this evaluation, we concentrate on the improvements that are designed to make NetWare a total network solution and increase productivity of both administrators and users.

These improvements involve several existing Novell products that come with NetWare, as well as some new ones added into the same box. The most important include a native TCP/IP protocol, a Java Virtual Machine, better management, easier installation, a new file system, enhanced

Novell Directory Service (NDS), a powerful database, and bundled DNS and DHCP servers. All of this and more comes with NetWare 5, which starts at \$1,195 for the server and 5 users and climbs to \$28,190 with an additional 500 users.

INSTALLATION AND UPGRADE

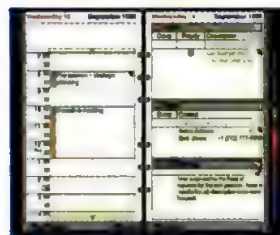
Although the NetWare installation procedure has improved greatly over the years, the character-based menu that you always had to trudge through in previous versions remained a sore spot. Fortunately, the folks at Novell finally listened to their customers and designed a graphical installation utility for NetWare 5. To make installation even easier, the CD that holds the OS is bootable and should work with most of today's CD-ROM drives.

The NetWare CD includes Caldera's DR-DOS, which pro-

INSIDE

GET ORGANIZED:

We review the latest PIMs from Lotus and Day-Timer plus take a peek at what's to come from Microsoft's Outlook 2000. *Page 50.*



WORKING FROM HOME TODAY?

pcTelecommute can make your home office a lot more like your real office. *Page 68.*

FULLY CONNECTED:

The first of the 802.11-compliant wireless networking systems, the BreezeNET PRO.11, has hit the market and we test it out. Take a look into networking's future. *Page 75.*



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First Looks Online

For daily just-in-time reviews of shipping products, check out First Looks Online at www.pcmag.com



First Looks

vides the utilities you'll need to create a new disk partition. The new installation routine also allowed us to do a complete, unattended installation by creating a script. The entire installation is Java-based and requires only about 30 minutes to complete, compared with the hour or more needed to install earlier versions. We also liked NetWare's ability to auto-

detect the plug-and-play devices in our test server, a Compaq ProLiant. Installing NetWare on a clean server is by far the easiest method, but the OS also includes several upgrade methods. To test these methods, we upgraded a NetWare 4.11 server to Version 5. First, however, the older server had to be running the latest version of NDS (Version 5.99a), along with the licensing service. Fortunately, this process is explained in the online documentation on a separate CD.

This upgrade process was not without its frustrations, however. Although NetWare 4.11 required only a 15MB DOS partition, Version 5 has raised that re-

quirement to 35MB. If you don't have enough room on your server (we didn't), you'll have to back up all of your data and recreate the partition table on the server's hard disk. We recommend making a DOS partition of at least 100MB so that your server

NetWare 5's graphical installation lets you easily repartition and reformat your hard disks.

will be able to handle the next version of NetWare.

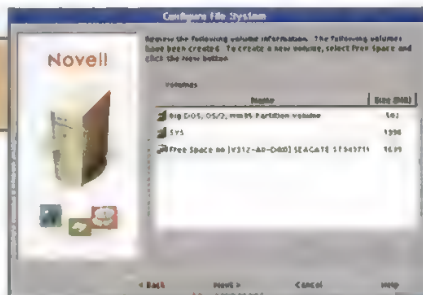
ENHANCED NDS

A global directory service is an important feature that Novell provides with NetWare. Though lacking in Microsoft Windows NT Server 4.0, this feature is expected to be supported in Windows NT Server 5.0.

Novell has made several improvements to NDS. One of our favorites is the new role-based management feature, which let us set up individual users with different management or access rights to the NDS tree. For example, we were able to assign the right to issue and revoke passwords to a specific user, as

well as to deny that user the ability to delete or create users and groups. This is a great tool for spreading the administrative workload among multiple users.

Another improvement to NDS is the addition of LDAP 3.0



compliance. NDS LDAP support allows you to tie your NDS tree into other LDAP directories, such as those available from Netscape. NetWare also includes a new WAN Traffic Manager that helps reduce network use—and therefore increase bandwidth—when the server synchronizes the NDS information with other devices on the network.

NATIVE IP

Older versions of NetWare did include the TCP/IP protocol,

but it wasn't pure. Specifically, the older Novell TCP/IP was really IP that encapsulated the Novell IPX protocol inside. In fact, older versions of NetWare relied on IPX to provide communication between the clients

and servers. NetWare 5 includes a native (or pure) version of TCP/IP and therefore doesn't require IPX at all. All of the server applications, including utilities such as Rconsole (remote console), work over TCP/IP.

Native support means that you can easily install

NetWare 5 on an IP-only network with other Windows NT and Unix servers. To maintain backward compatibility with older IPX-based services, NetWare 5 also includes an IPX-to-IP gateway. If you install NetWare configured as an IP-only network, you will find that the IPX-to-IP gateway is a good way to protect one network that's attached to another. For example, with the gateway you can run IPX on your internal network—and run IP on your connection to the Internet. This will shield your internal network from outside users.

Before we could log in to our NetWare 5 server using the IP protocol, we first had to install the new NetWare client. The NetWare 5 package includes client software for Windows 3.x, Windows 9x, and Windows NT Workstation. The new client software was a breeze to install, and we were able to create a script to update our existing client PCs automatically the next time they logged into the NDS tree.

LOWERING TCO

There are dozens of components that affect a network's total cost of ownership, but managing and troubleshooting client PCs are two of the biggest. To help with these procedures, Novell has bundled the Z.E.N.works starter pack with NetWare 5.

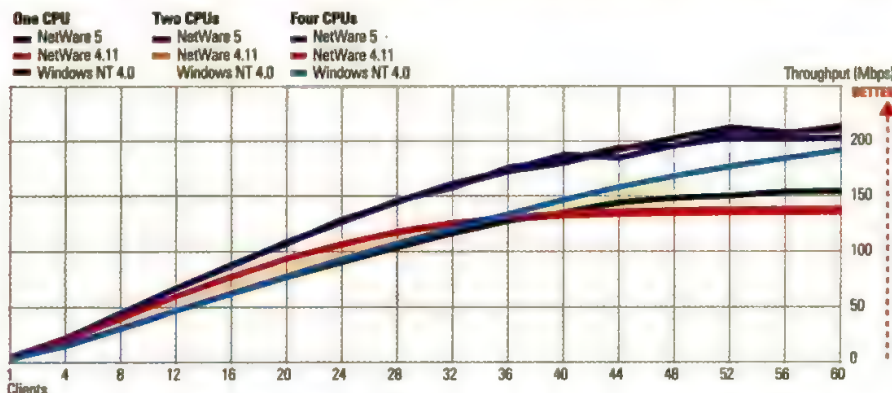
NETBENCH TESTS

NetWare 5 vs. 4.11 and Windows NT

PC MAGAZINE LABS NetBench test results show how well a NOS performs as a file and print server—historically NetWare's strong suit. And our test results reinforced NetWare's dominance in the file-and-print space: With a 60-client load, Version 5 posted throughput scores that were 50

percent higher than Version 4.11 achieved.

NetWare 5 also significantly outgunned Windows NT Server 4.0 on our NetBench tests. The difference was most dramatic in a single-CPU configuration; Windows NT closed the gap somewhat when run in dual- and quad-processor server configurations.



Z.E.N.works lets you distribute software, gather hardware inventory, control what applications a user can access, and control client PCs remotely.

The Z.E.N.works starter pack lacks only the hardware inventory and remote-control modules of the full-blown version. One of Z.E.N.works' best features is its ability to lock down a user's PC. On our tests, we were able to disable certain Control Panel applets as well as remove the Find and Run commands from the test user's desktop. Microsoft offers similar functionality for Windows NT with its Zero Administration Kit (ZAK).

If you've ever had to respond to a trouble ticket because an end user added a new program or deleted a system file, you'll like the update and bug-fix features in Z.E.N.works. To test this feature, we created a package that would install Microsoft Word on our client PCs. We then went to the client PC and deleted several DLLs that belong to the Word application. When we tried to launch Word, the Z.E.N.works agent noticed the missing files, connected to the original file locations on the server, and replaced only the deleted files. Best of all, Z.E.N.works accomplished this task without any user intervention.

JAVA VIRTUAL MACHINE

In the past, about the only time you'd ever walk over to your NetWare server was to turn it off if something went wrong. The server's character-based console was useful only for loading modules; you couldn't use it to manage users or to run major server-based applications.

The new version of NetWare, however, includes a Java Virtual Machine (JVM) that runs directly on the server. This means that you can launch any Java applet from the system console. Some of the tasks that you can perform include running a Tel-

SERVERBENCH TESTS

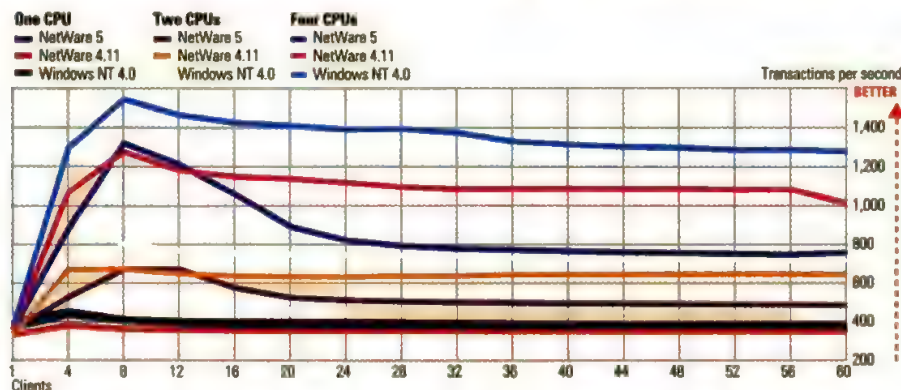
NetWare 5 vs. 4.11 and Windows NT



On our ServerBench tests—which measure how well a NOS performs as an application server—NetWare 5's scores fell far short of those posted by Windows NT 4.0. These results were not terribly surprising, as Windows NT has historically outperformed NetWare

as an application server.

We were surprised, however, that NetWare 5 actually performed worse than its predecessor, Version 4.11. These results are due mainly to the manner in which NetWare's file system handles caching, which hasn't changed in the new version.



net session or Web browser on the server. In fact, the JVM should work with any Java applet you create or download from the Internet; this will make it easier, going forward, for ISVs to write applications for NetWare. You can even run the new ConsoleOne utility (discussed in detail below) directly from the server's keyboard.

We thought that it was pretty

system memory. We recommend you unload the JVM if you're not planning to use it.

TASK MANAGER

Building on the Java platform, NetWare 5 introduces ConsoleOne, a graphical management utility. This Java applet allows you to perform several of the tasks that you would normally use the Windows-based NWAdmin utility to complete. For example, we were able to use ConsoleOne to create users and assign specific rights. As an added bonus, ConsoleOne will run on any computer that has a JVM installed, including the NetWare 5 server. This means that you can perform management tasks and run applications, such as Rconsole, directly from the server's console.

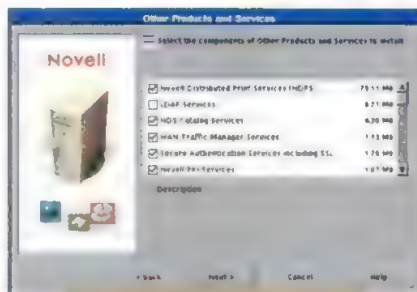
Unfortunately, we found that ConsoleOne runs extremely slowly, even on a 266-MHz Pentium II PC. We were also unable to use ConsoleOne to manage our NDS tree or to perform other NWAdmin tasks. As Nov-

ell ports more functionality over to the Java-based ConsoleOne, this feature will become a valuable and ubiquitous tool. For now, however, you'll have to stick with your old Windows-based utilities.

BUILDING AN INTRANET

The tide today is turning toward the use of Internet technologies and applications to access internal network resources. The concept is based on using ubiquitous applications (like a browser) and protocols (like TCP/IP) on your LAN. NetWare bundles several different applications to help you build your own intranet, including DNS, DHCP, and HTTP/Web servers.

The DNS server lets you give your network resources (including servers, clients, and printers) easy-to-understand names instead of the confusing IP addresses. Likewise, the DHCP server allows you to assign an IP address to your resources automatically. But the best feature of the DNS and DHCP servers is that they tie into the NDS tree. This lets you use a single management utility



You can choose from several services, including LDAP support when you first install the NetWare OS.

neat to be able to run applications on the server, but we found that these applications performed slowly, and that running the JVM and an applet require several megabytes of valuable

First Looks

(in this case, NWAdmin) to set up users, assign them a name, and lease an IP address to them. Windows NT 4 also includes DNS and DHCP servers, but they don't tie together in a single management console.

To complete the intranet package, NetWare includes a copy of Netscape's FastTrack Server. FastTrack is an entry-level server that is integrated with NDS for security administration and supports open development standards.

NetWare eases the task of setting up the TCP/IP protocol on your new server.

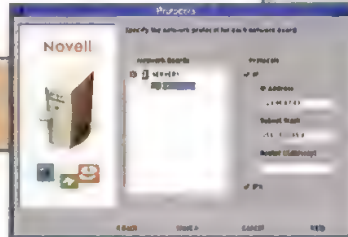
NOVELL STORAGE SERVICES

If your NetWare server crashes or you have to reset it, you can expect to wait several minutes to over an hour while the disk volume remounts. If there are problems with the volume—due to a crash, for instance—add at least another 30 minutes to run the utility Vrepair (volume repair).

If you have hundreds of gigabytes of data, it can take several hours to bring a server back online. In an effort to shorten this time, Novell developed the Novell Storage Services (NSS). You

can mount a multigigabyte or even terabyte-size NSS volume in seconds. NSS also reduces the amount of time it takes to run Vrepair.

In addition to increasing the speed for mounting volumes, the NSS file system can handle more data—up to 8 terabytes in a single NSS file. Another improvement is the amount of RAM re-

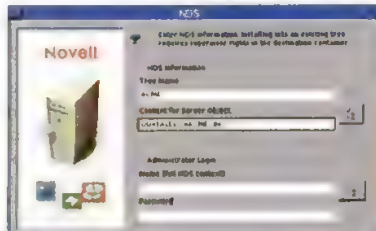


quired for NSS volumes. Older NetWare file system volumes required approximately 0.008MB of system memory per megabyte of storage. The rule we used to follow was 16MB of RAM for every 1GB of hard disk space. NSS, on the other hand, can use as little as 4MB of RAM for a 500GB volume. Unfortunately, NSS doesn't currently work with RAID levels 0 and 1, as the older file system did. Novell plans to

add this functionality in a later release.

BEEFED-UP DATABASE

NetWare has always had a data-



base—that is, if you can call the built-in Btrieve engine a real database. NetWare 5 continues to be backwards-compatible with Btrieve applications, but this new version also includes a five-user license of Oracle Corp.'s Oracle8 database.

The inclusion of Oracle8 is a good way to make NetWare a better application server platform. There are dozens of Oracle-based applications that you can now run on your NetWare server without having to rely on Windows NT or Unix.

PERFORMANCE

To test the performance of NetWare 5, we used both our NetBench and ServerBench tests. We put the NOS through its paces using the TCP/IP protocol (since this is the default) on a 60-client network split into two full-duplex, 100-Mbps segments of 30 clients each. We also tested NetWare 4.11 and Microsoft Windows NT Server 4.0 for comparison under the same network test conditions. Three sets of tests were performed on each NOS, using one, two, and four CPUs in our test server.

On our NetBench tests (which gauge the capabilities of the NOS as a file and print server), NetWare 5 performed extremely well, outrunning both NetWare 4.11 and Windows NT Server 4.0 in all test configurations. With 60 clients in a four-CPU configuration, NetWare 5 outperformed NetWare

4.11 by nearly 50 percent.

ServerBench test results were a radically different story, however. The ServerBench suite tests how each NOS performs as an application server. According to the results, NetWare 5 actually performed

It's easy to set up a new NDS tree or connect to an existing one when you install NetWare 5 on your server.

worse than NetWare 4.11.

Even though Novell redesigned the kernel for NetWare 5, the company didn't change the way NetWare's file system handles caching. The native file system does not allow write-back caching during file I/O (unlike Windows NT), meaning that the system waits for each write to commit before returning control of the application. The upshot is slow performance.

According to Novell, NetWare's synchronous-only native file system was designed to ensure data integrity and to prevent loss of cached data in the event of a power failure or system shutdown. NetWare 5 does have a new—although optional—file system that can be set to either synchronous or asynchronous operation. Novell is currently experimenting with tuning this new file system for better performance and may release a service pack in the future to address the issue.

THE BOTTOM LINE

If you need a strong directory service, native TCP/IP, intranet capabilities, and superb management, consider upgrading your current NetWare servers to Version 5. Likewise, if these features are important to you and you are currently using Windows NT Server 4.0, think about how long you feel like waiting for Windows NT Server 5.0.

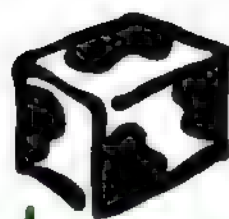
NetWare 5. List price: For five users, \$1,195. Novell Inc. South Provo, UT; 888-3231-4272; 801-228-4272; www.novell.com; 400 at www.pcmag.com/infolink. **PC**

SUMMARY OF FEATURES

NetWare 5 vs. Windows NT 4.0

	NetWare 5	Microsoft Windows NT Server 4.0
List price for server and 5 users	\$1,195	\$809
Platforms supported	Intel	Alpha, Intel, MIPS
Minimum hardware requirements	486 CPU, 64MB RAM, 200MB hard disk space	486 CPU, 16MB RAM, 200MB hard disk space
Multithreaded/multitasking OS	■ ■ ■	■ ■ ■
Total RAM supported	4GB	4GB
Protocols supported	AppleTalk, IPX, NetBIOS, TCP/IP, UDP	AppleTalk, DLC, IPX, NetBEUI, TCP/IP
Native IP	■	■
Total CPUs supported	32	8
Built-in messaging/e-mail	■ ■	■ ■
Built-in backup	■	■
Desktop management	■	■ (through ZAK)
Directory service	■	■
FTP / HTTP / LDAP support	■ ■ ■	■ ■ ■
Content filtering	■	■
DNS / Dynamic DNS support	■ ■	■ ■
DHCP	■	■
Telnet	■	■ (client only)

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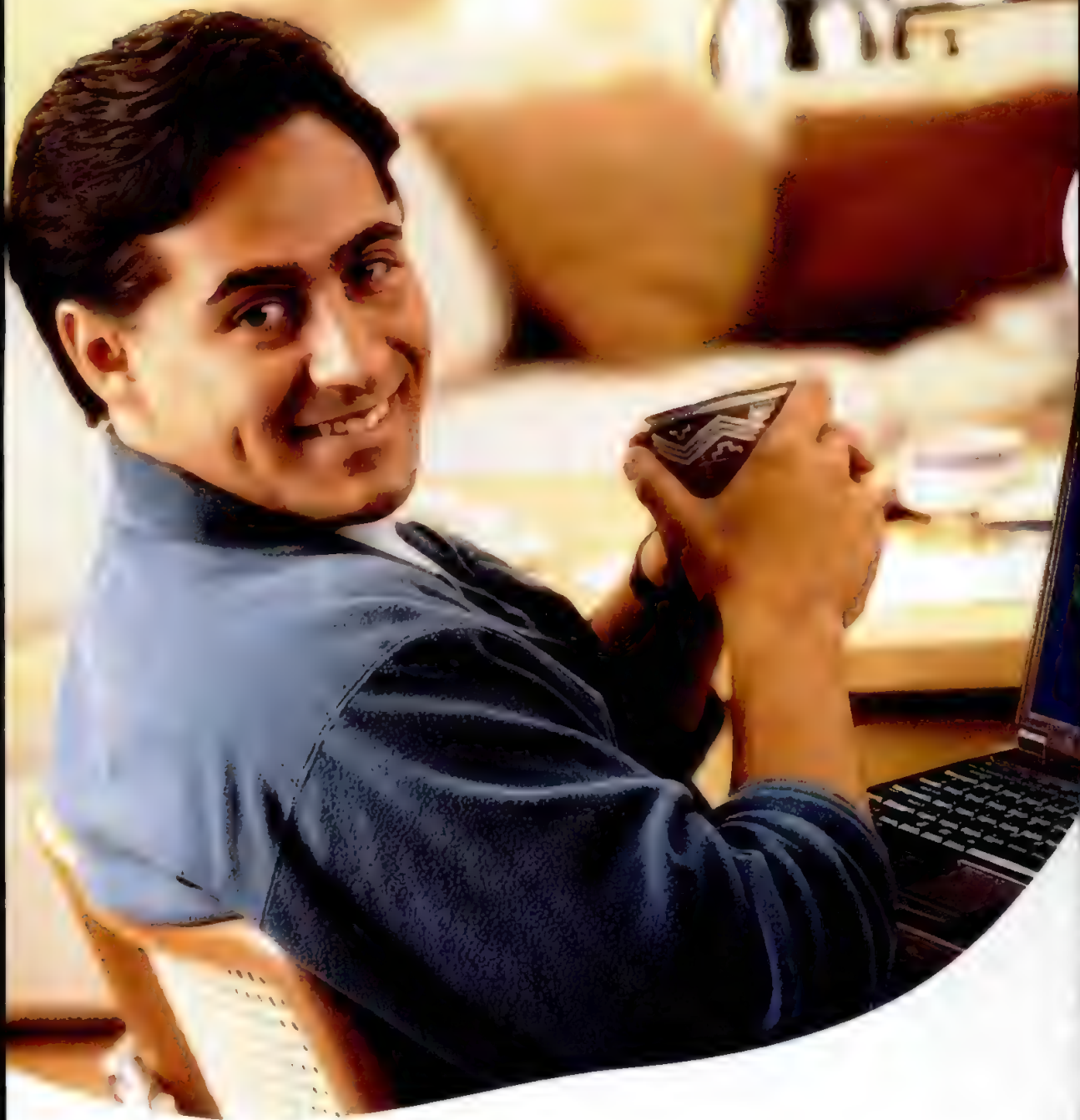
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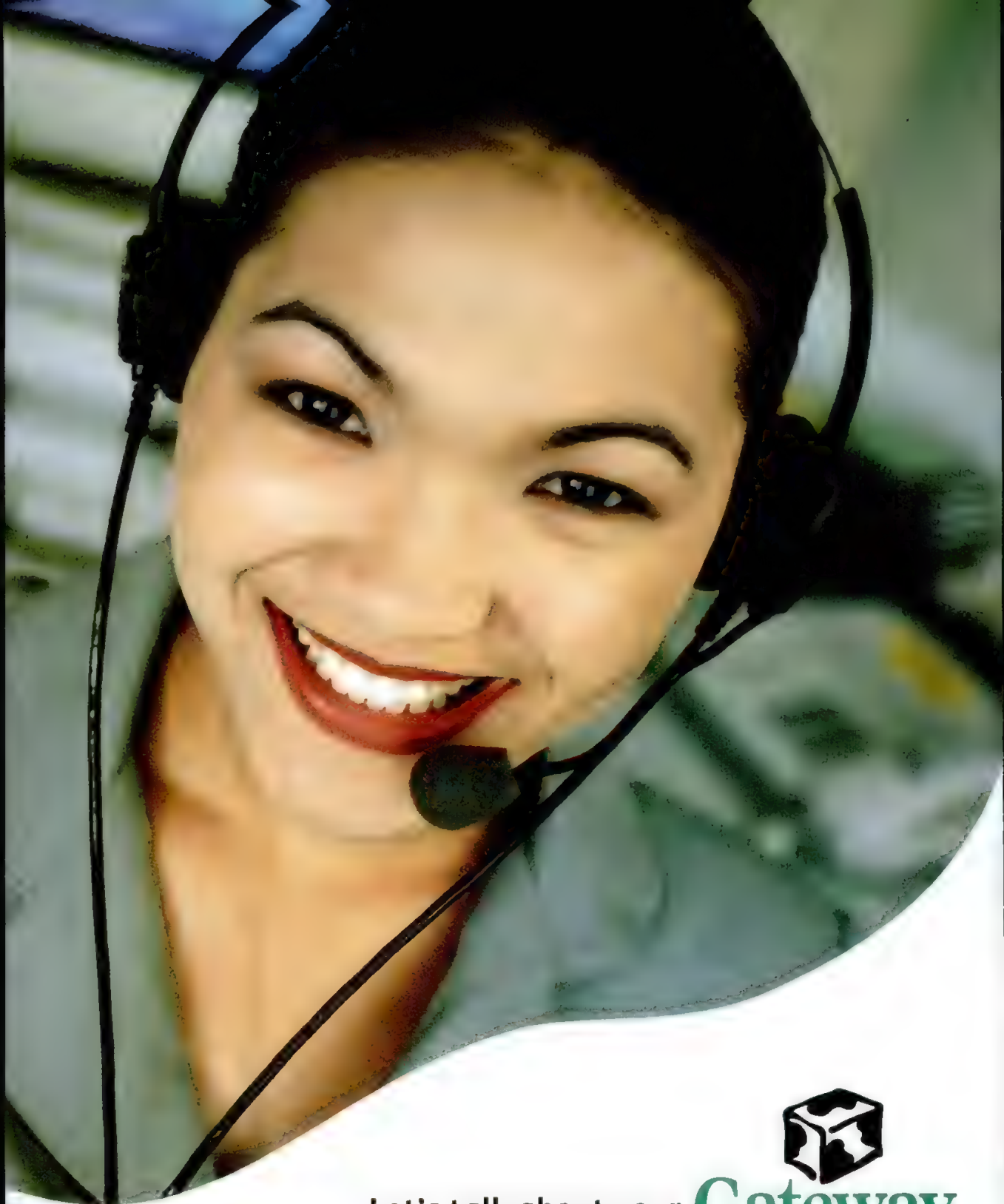
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First Looks

PERSONAL INFORMATION MANAGERS

What's Next for PIMs

We take a look at the latest versions of Day-Timer Organizer and Lotus Organizer.

By David Haskin

Cynics might argue that personal information managers (PIMs) are a mature software category with nothing new to offer. New releases of the popular Day-Timer Organizer (DTO) and Lotus Organizer, however, show that, like diamonds, the more you polish a good PIM, the more valuable it becomes.

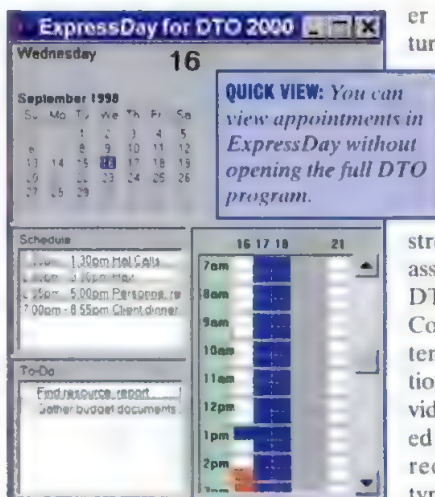
Both PIMs have long favored ease of use over power. With these releases, however, they show increased power without giving up any of their highly regarded simplicity. Some professionals will still need the power of complex database-like contact managers, such as GoldMine. But DTO and Lotus Organizer provide all the power for managing contacts, appointments, and tasks the rest of us will ever need, without having to

learn how to use a complicated contact manager.

DAY-TIMER ORGANIZER 2000

Two previous versions of Day-Timer were Editors' Choice winners. This latest upgrade, Day-Timer Organizer 2000 (\$60 street), still resembles an electronic version of the company's familiar paper organizers. Although this interface isn't quite as polished or as simple as Lotus Organizer's, behind it lurks much more power.

This upgrade seamlessly imports information from Microsoft Outlook, Schedule+, and Symantec's ACT!—without the need to map fields in one database to fields in another, which can be a maddening process. In addition, synchronizing with other Day-Timer databases and personal digital assistants like PalmPilot is now equally simple.



The previous version of DTO introduced ExpressServices, which lets you access basic information in your DTO database by clicking on system tray icons, even if the program isn't open. DTO 2000 increases the amount of information you can access through this method. For instance, the new ExpressDay service shows your appointments and tasks for the current day, and ExpressContact lets you find contact information quickly. DTO 2000 also adds some small-

er (and overdue) features, such as support for vCard and vCalendar and a spell-checker.

Beyond that, DTO's traditional shortcomings and

strengths remain. One asset is the sheer bulk of DTO 2000's records. Contact records have ten tabs full of information, and DTO 2000 provides a virtually unlimited capacity to customize records—capabilities typically found in full-

fledged contact management software. In addition, like contact managers, DTO 2000 keeps a history of your interactions with contacts. All your meetings, phone calls, and letters show up in the contact's history list.

DTO's calendar and task modules have virtually all the significant PIM capabilities, such as setting up recurring appointments, warning you of scheduling conflicts, and helping you find free time. In addition, you can attach files to any record.

A Quick Peek at Microsoft Outlook 2000

Like many Microsoft products, Outlook immediately grabbed a large chunk of market share. This was due in part to Outlook's tightly integrating e-mail with other personal information. Nobody has ever accused Outlook of being easy to use, however.

Microsoft Outlook 2000 (to be released with the rest of the Office 2000 suite, due out at the beginning of 1999) will shore up both its biggest strength—communications—and improve on its main weakness—usability. Most of the usability improvements are small but add convenience. For instance, in the beta we examined, Microsoft streamlined the contact history window.

The e-mail rules wizard, for routing e-mail to the appropriate folder, will be handier with the ability to run rules manually whenever you want. In addition to creating messages with the built-in text editor or Microsoft Word, you'll be able to create them in RTF and HTML.

Outlook 2000 will fully support iCalendar, a Web-based scheduling protocol that appears to be gaining acceptance.

You can save a calendar in HTML and post it on the Web.

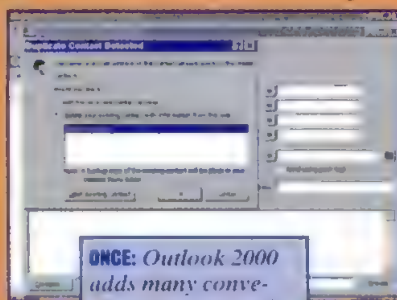
Microsoft is adding features to simplify record keeping. If Outlook suspects a new contact record you're creating duplicates an existing one, the program will warn you. Although the ability to book meeting resources (such as conference rooms) wasn't in the beta version we saw, Outlook 2000 will include this common feature.

Even with all these new convenience features, Outlook 2000 isn't as simple as DTO 2000 or Lotus Organizer 5.0. Its search capabilities, for instance, are powerful, but the dialog box for framing complex Boolean searches remains dense. And Outlook 2000 still can't

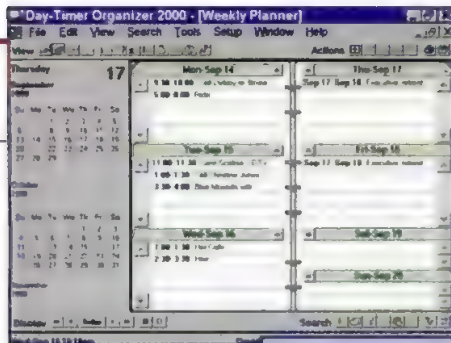
synchronize with another Outlook database (unless your organization has implemented Exchange Server) or with PDAs without extra-cost software.

Microsoft Outlook 2000 is a strong choice if e-mail is an essential part of your personal information. —DH

Microsoft Outlook 2000. Microsoft Corp., Redmond, WA; 800-426-9400; www.microsoft.com; 417 at www.pcmag.com/infolink.



ONCE: Outlook 2000 adds many convenient features, such as checking for redundant database entries.



We reviewed the standalone version, but DTO 2000's work-

group contact management capabilities are largely unchanged and are among the strongest we've seen in a PIM. With the workgroup version, if you assign tasks or appointments to other workgroup members, DTO 2000 will notify them via e-mail and keep a group calendar.

Some of DTO 2000's attempts at improvement do fall short. For instance, its so-called area-code splitter aims to simplify the task of reassigning area codes when they change, but though well intentioned, it's a confusing tool with limited use.

The company also failed to shore up other shortcomings in this upgrade. You can start an e-mail message to a contact by clicking on an icon in his or her record, but unlike PIMs such as Microsoft Outlook, DTO 2000 can't receive or manage e-mail. In addition, the software can perform complex Boolean searches, but creating those queries can charitably be described as clumsy. DTO 2000 also uses separate dialog boxes for searching different types of records, such as appointments or contact records, which is awkward.

As before, DTO 2000 employs a multiple-document interface, opening a new window for every view. For example, if you examine your calendar in daily view, then click toolbar icons to view weekly and monthly versions, DTO 2000 opens three separate windows. Although this lets you drag and drop information easily among mod-

ules, it also creates a lot of screen clutter.

Day-Timer Organizer 2000 adds polish and power to an already highly regarded product. It's an excellent bet if you need PIM power but

can't tolerate the complexities of learning a more complicated product.

Day-Timer Organizer 2000. Street price: \$60 (\$30 upgrade). Requires: 8MB RAM, 10MB hard disk space, Microsoft Windows 95 or NT 4.0. Day-Timers Inc., East Texas, PA; 800-225-5005, 610-398-1151; www.daytimer.com. 416 at www.pcmag.com/infolink.

LOTUS ORGANIZER 5.0

One reason for Lotus Organizer's popularity over the years is its comfortably familiar interface which, like DTO's, resembles a paper daybook. Organizer has always been one of the simplest PIMs, but it's also been one of the most underpowered.

Lotus Organizer 5.0 (\$80 street) adds more power, which helps it catch up to other PIMs. The most notable improvement is that Lotus has beefed up Organizer's contact database. Con-

ture that many PIMs, including DTO, have long since adapted. You can view the history on a separate page next to the record or in a dialog box. In either case, you can jump right from an item in the contact history (such as an appointment) to that item.

Print preview is another new—and overdue—feature. You can add contacts via LDAP lookups and, in a related vein, Organizer 5.0 now supports vCard and vCalendar for quickly adding information to your PIM database.

The product also has support for the iCalendar standard for posting free and busy time on a Web server. The iCalendar information can then be integrated into other iCalendar-compatible PIMs. Lotus Organizer is currently the only such PIM available, although others, including Microsoft Outlook 2000 (see the sidebar).

Also new is a summary view that shows in a single screen all your appointments, tasks, calls, and diary notes for the current day. This is similar to Microsoft

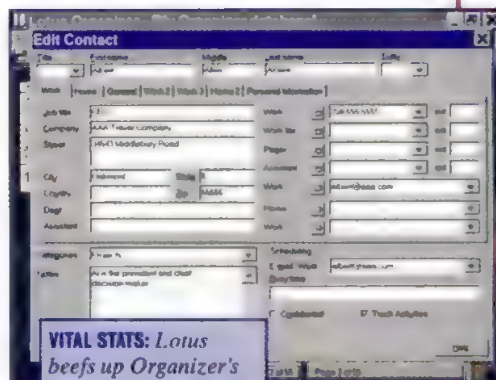
Outlook's Outlook Today feature, but it displays more information on screen.

Organizer can also automatically import your database from other PIMs and contact managers, including ACT!, DTO, Outlook 97 and 98, and Sidekick, without the need to map fields in the two databases. For other imports, you still must map, which remains particularly frustrating in Organizer.

Organizer's views are the easiest to read that we've seen for weekly and monthly appointments. And as before, Organizer has excellent scheduling abilities. You can use any e-mail

client to send invitations to meetings. Organizer can now scan your mail client's in-box for responses and then perform such tasks as automatically adding them to your calendar.

Another useful feature is EasyClip, which was in the previous version. This feature lets you highlight information in any application, such as your word processor or Web brows-



VITAL STATS: Lotus beefs up Organizer's contact record, adding many fields.

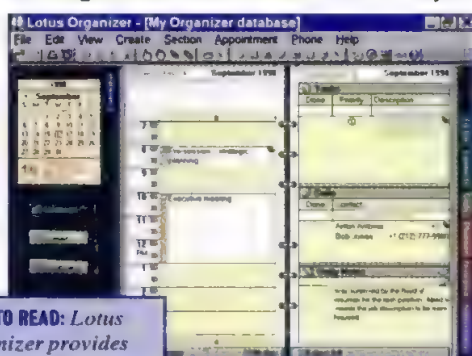
er, and automatically add

it as a record in Organizer, even if the PIM isn't running. Even in the copycat world of PIMs, no other PIM has duplicated this useful capability.

Like DTO 2000, you can launch e-mail messages from a contact record. Organizer 5.0 can scan your mail client's In-box for new mail, and if there is a new message, an icon wiggles to notify you. Also like DTO 2000, Organizer still can't receive or manage messages, nor does it yet support mail merge with Corel WordPerfect or Microsoft Word (although it does with Lotus Word Pro).

Lotus Organizer 5.0 still doesn't match DTO 2000's capabilities, but its interface is easier to learn. And with this upgrade, Organizer 5.0 now provides adequate power for most users.

Lotus Organizer 5.0. Street price: \$80 (\$20 competitive upgrade rebate). Requires: 8MB RAM, 17MB hard disk space, Microsoft Windows 95, 98, or NT 4.0. Lotus Development Corp., Cambridge, MA; 800-343-5414, 617-577-8500; www.lotus.com; 415 at www.pcmag.com/infolink.

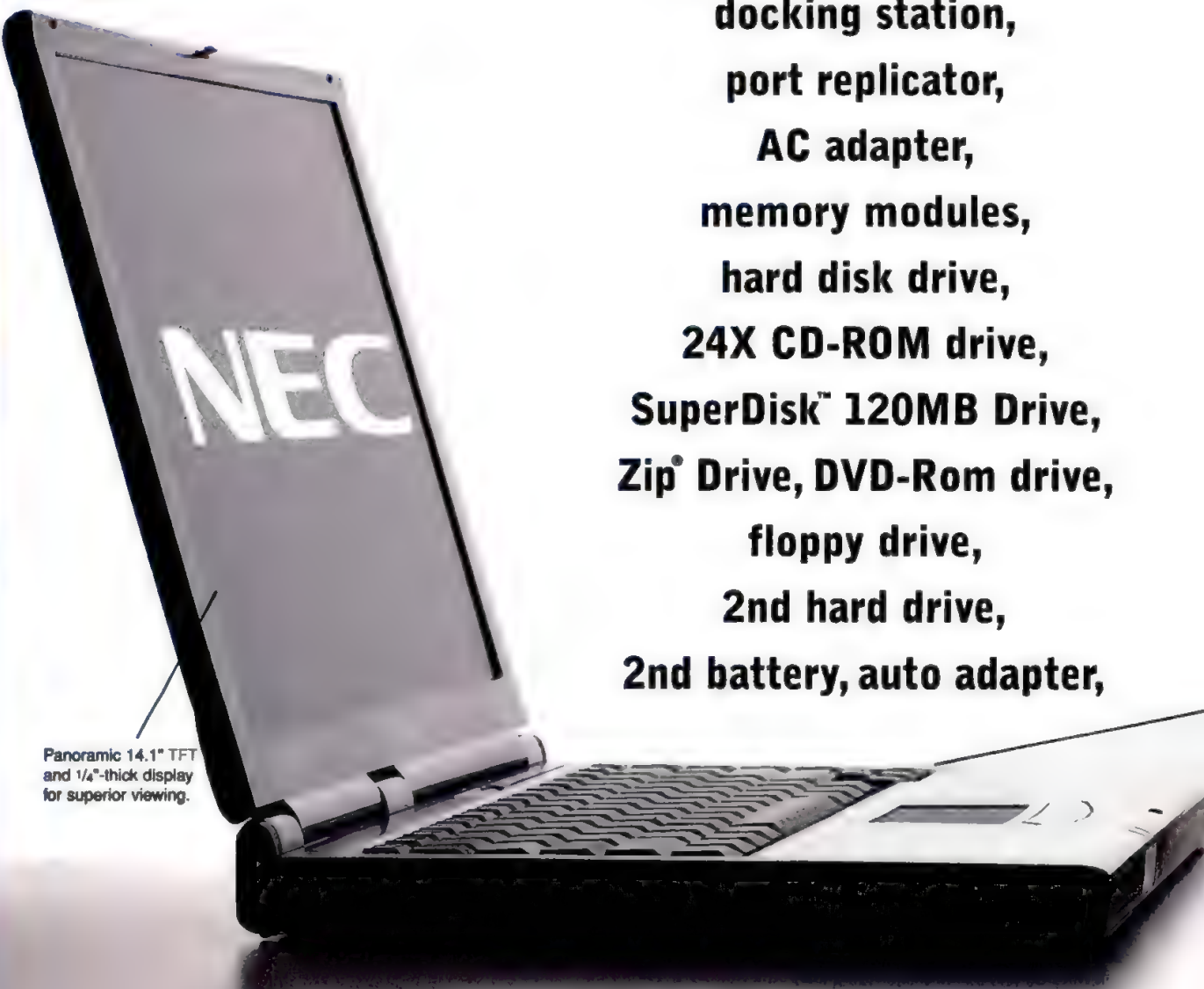


EASY TO READ: Lotus Organizer provides the cleanest screens we've seen for viewing personal information.

tact records can now display as many as 158 fields, which is about five times as many as in previous versions. Organizer 5.0 now has 20 separate fields for phone numbers, for example.

In addition, Organizer 5.0 now keeps a history list of your interactions with contacts, a fea-

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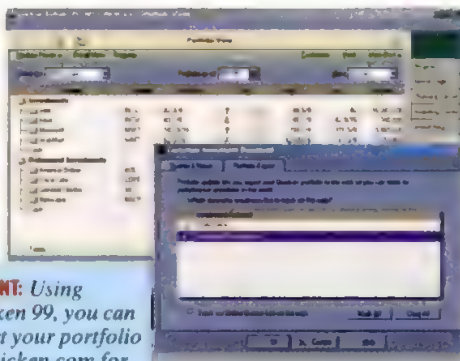
Quicken 99's one-two punch—improved navigation and Web connectivity—parries Microsoft's Money 99's jabs.

By Kathy Yakal

One of the reasons people shy away from personal finance software is the drudgery of transaction entry. Quicken 99 (\$60 street) has an answer to that problem—and a lot more.

Quicken 99 has two new data-entry options: Quick Entry is a simple transaction register that you install on your PC; or you can also enter transactions on a personalized page in Quicken.com from any Web-enabled PC. Both methods dump your data into Quicken.

ACCOUNT: Using Quicken 99, you can export your portfolio to Quicken.com for Web-based tracking.



The new Financial Highlights Center acts as a clearinghouse for local and Internet-based financial information. Built like a Web page, this customizable scrolling screen displays text and graphical readouts of your current financial sit-

uation, either directly on the page or via links to other program screens.

Each area of Quicken 99 (tax, home and car, banking, investments, and planning) has a similar, modifiable central page, with links to both internal Quicken pages and related Web sites. The pop-up lists along the screen's edge remain from previous versions, as do the pull-down menus and bookmark tabs.

Data import is more graceful in Quicken 99. The new One Step Update lets you grab data from all your online accounts with one password and one connection. Financial institutions with transactional Web sites can send your account data directly to Quicken 99.

Less all-encompassing—but still potent—enhancements are sprinkled throughout Quicken 99. Quicken 98's tax tools have

been enhanced with a clever new feature: Type in a category like "babysitting" when you already have a similar tax-related category like "child care," and Quicken will recognize it as a deductible expense. New What-If scenarios, the inclusion of Quicken Financial Planner in Quicken Deluxe, and new investment features like a capital gains estimator add fuel to Quicken's fire.

Intuit has combined big-picture changes in Quicken with a continued shoring up of the underlying financial management structure that's kept the company's software on top for over a decade. Intuit has risen once again Microsoft's challenge.

Quicken Deluxe 99. Street price: \$60 (\$20 upgrade rebate). Requires: 12MB RAM, 37MB hard disk space, Microsoft Windows 95, 98, or NT 4.0 or later. Intuit Inc., Mountain View, CA; 800-446-8848, 650-944-6000; www.intuit.com; 413 at www.pcmag.com/infolink.

DOCUMENT-EDITING SOFTWARE

Your Words on the Web

Trellix 2.0 makes it simple to create long, easily navigable documents for posting on the Web or your Intranet.

By Ben Z. Gottesman

One of the biggest challenges facing businesspeople as they embrace the Web is learning to author long documents, such as annual reports, in a format that's easily digested in a browser. Trellix 2.0 (\$249 list) takes on this task and proves to be one of the best programs we've seen for creating long Web documents and even small Web sites.

Trellix is something of a hybrid of Microsoft Word, PowerPoint, and a Web-authoring tool. Each Trellix document is split into two areas, the map section and the page area. The map shows all of the individual pages and is one of the keys to Trellix.

Groups of pages can be kept together in a sequence, and each

sequence can be linked to a higher-level page. These sequences can then be used as navigational aids on individual pages. As pages are added, removed, or modified, the navigational lists update automatically. Trellix maps can also store tours, which can be guide users through a subset of pages.

As with PowerPoint, you apply layouts to a page and define its look. In addition to the main body of a Trellix page, each page can contain frames, which are generally used for document navigation or page summaries.

Version 2 of Trellix adds support for tables and can act as an

OLE container, although objects cannot be edited in-place. Pages can include hyperlinks to other areas of the document or to pages on the Web. Container pages let you view a Web page as a frame in your Trellix document.

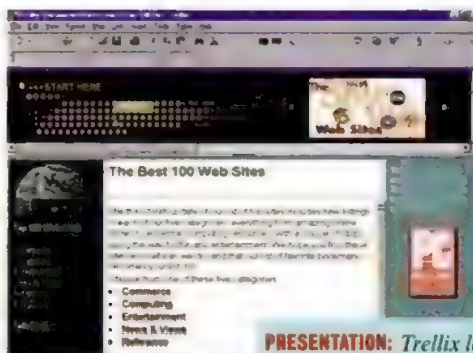
Authoring documents in Trel-

ported to HTML with near-perfect fidelity. The Web pages can be packaged with a mini-Web server into a single file for reading off-line. You can also read documents in their native format using the freely distributable Trellix viewer.

If you want complete control over your layout and HTML code, Trellix might not be for you. But for most business users who just want a way to publish attractive and easily navigable documents, Trellix is worth a good, long look.

Trellix 2.0. List price: \$249 (\$69 upgrade). Requires: 24MB RAM (32MB for Microsoft Win-

dows NT), 28MB hard disk space, Microsoft Windows 95, 98, or NT 4.0 or later. Trellix Corp., Waltham, MA; 800-266-0879, 781-788-9400; www.trellix.com; 414 at www.pcmag.com/infolink.



PRESENTATION: Trellix lets you easily create attractive, well laid-out Web sites.

lix is easy, but you can also create documents in Word. Although documents can be imported only from Word, the process is intelligent, breaking documents into individual pages based on styles or font size.

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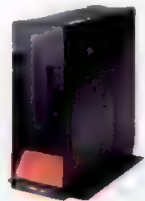


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A black and white photograph of a man with dark hair, smiling and leaning on a bicycle. He is wearing a dark, long-sleeved shirt and light-colored pants. The bicycle is a mountain bike with a dark frame and knobby tires. The background is plain white.

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First Looks

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Building in 3-D

3D Studio VIZ R2 brings your blueprints and CAD drawings to life with sophisticated rendering tools.

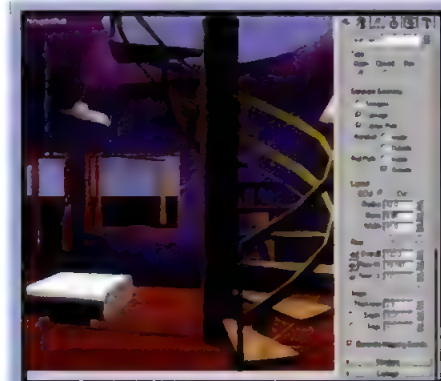
By Linda Von Schweber

Designed for architects, engineers, and CAD (AEC) professionals, 3D Studio VIZ R2 (\$1,995 direct) from Kinetix can make quick work of turning imagination-challenging blueprints and CAD drawings into photo-realistic pictures. VIZ uses the same interface and file format as Kinetix's 3D Studio MAX ("Animate on the High End," a First Looks review, October 20, 1998) but adds special tools for AEC professionals and removes the more sophisticated modeling and animation capabilities.

AEC professionals will especially like how closely VIZ works with AutoCAD DWG files. You can import a DWG elevation, such as a 2-D outline of a wall with window and door spaces, stand it up and extrude it so it has some depth, add awnings, insert "smart" doors and windows and apply materials such as concrete, brick, and glass. The DWG Link Manager updates the VIZ scene when the DWG file changes.

One of the new AEC-specific object types let us create connected walls as easily as drawing

lines in a vector illustration program. We added windows and doors, including wall holes, by simply dragging out their height, width, and depth. We moved them around for final positioning and used spinners to open and close them.



BEFORE AND AFTER: The screen on the left shows how you see the scene while you're working in VIZ. You can't see the environmental effects of the water, waves, sunlight, and some of the lighting. The rendered image on the right shows how the same shot looks when you render it to disk.

VIZ provides six different materials and/or texture maps for the windows, one each for the interior and exterior; front, back, and rail trim; and glass. There are similarly smart stairs, terrain, foliage, and railing/fencing objects and materials.

Stairs were amazing to work

with: Two mouse clicks produced an open, closed, or boxed-in spiral, l-type, u-type, or straight stairway. We set the stairway's stringers, carriage, and a handrail with a number of posts and segments and controlled the thickness, depth, and number of steps; the height, width, and depth of the entire staircase, and more.

MODEL

Decorating interiors and detailing exteriors requires modeling, and VIZ offers such tools as

alogs; NURBS and Patch Surfaces give you even greater control for creating detailed objects.

VIZ offers standard lighting and also allows you to set up sunlight for any position on the planet on any date and at any time. This is invaluable when viewing the impact of shadows cast by a new building.

The Environment Generator automatically builds land covered with grass or earth or a surface of water that reflects clouds in the sky, with settings for wave



primitives, their modifiers (like free-form deformation and transforms), and subobject spline and mesh editing. Paths are built from 2-D spline shapes, which you can also extrude, lathe, and loft. Compound objects are created using Boolean, connect, and scatter rollout di-

size, speed, and height. You can create and move mountains, set the color, size, and density of clouds, and animate the movement of the sun across the sky.

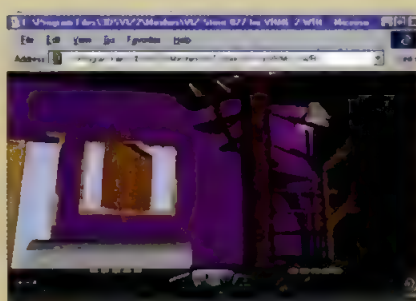
ANIMATE

We created keyframe animations by simply clicking the Ani-

MAX and VIZ Do VRML, Too

When you want to create interactive real-time animations and not just movies, you'll turn to the new but limited VRML97 import and the already robust VRML97 export plug-ins, which come included with both Kinetix's 3D Studio VIZ R2 and 3D Studio MAX R2.5.

VRML97 (Virtual Reality Modeling Language) allows anyone with Netscape Navigator 4.05 or a full distribution version of IE 4.01 to explore animated scenes or objects interactively without 3-D software. 3D Studio MAX provides great modeling



EXPORT: The VRML version doesn't show the water, waves, or sunlight in the scene.

and animation capabilities for producing VRML scenes and characters for the Web. Architects who use VIZ will find that they can export walkthroughs easily, and engineers can export new product designs to VRML97 and e-mail or post them to a Web site so that others can explore the models interactively.

Although the results can be impressive, be on guard to avoid producing bloated VRML97 files. MAX exports simulations built with dynamics, such

mate button, dragging a time slider to a new location, and making a change (such as opening a window and a door). Walk-through Assistant let us simply draw a path through the scene, set the viewer's eye height, and use a slider to move the head left, right, up, and down. Instantly, we had an animated camera moving through the scene. You can use VIZ interactively with your clients to make instant changes or you can render animations as AVI or MOV files.

Because VIZ lacks any great character-animation capabilities, we couldn't easily animate people walking through the scenes. VIZ is limited to forward kinematics rather than inverse kinematics, which means if you pull on a shoulder the hand will follow, but if you pull on the hand, the shoulder will not.

VIZ doesn't support motion capture, bones, particles and dynamics, space warps, or Video Post capabilities for compositing. Your animations will be professional looking but not full of Hollywood special effects.

SmoothMove Panoramas let us easily create and view a 360-degree spherical panorama, which lets a user stand in the middle of the lobby of a building and look around. The Camera Match utility allowed us to place a new building into a bitmap photograph of an existing site, matching perspective and camera angle.

as gravity and wind, and character animations built with Inverse Kinematics. The key is how you set the Animation Sample Rates in the export dialog. We reduced a VRML export of a walking robot from 1,686K to 822K by changing the setting from 25 frames per second to 1, without seeing any difference. We could have reduced this even further by using the Optimize Modifier for simplifying geometry.

Both MAX and VIZ rely on Helper objects for inserting VRML-specific capabilities, such as backgrounds, anchor links, and in-line files. You can create one animation and trigger either a range of keyframes or specific objects to animate upon entering the world or via touch, proximity, or time sensors.

Put Pen to Paper Digitally

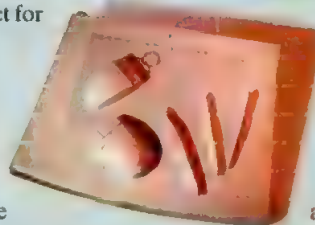
With the release of its Intuos Graphics Tablet System, Wacom solidifies its position as the leading manufacturer of pressure-sensitive input devices. The Intuos product line offers digital artists a wonderfully responsive and flexible set of tools.

We tested the new 9- by 12-inch Wacom Intuos Intelligent Tablet System (\$450 street), which is perfect for standard 8 1/2- by 11-inch paper. But there are Intuos tablets to fit any desk and every budget.

We were particularly impressed with the variety of input devices available. The primary tool is the Intuos Pen, which has a tapered ergonomic design to accommodate different grips and hand sizes, an eraser tip, two programmable button positions, and 1,024 levels of pressure sensitivity. The 9- by 12-inch tablet also includes a 4-D mouse with a thumbwheel designed to let you zoom a 2-D picture, navigate a 3-D environment, or shuttle video tape.

A breakthrough feature, Tool ID, provides the rationale for purchasing additional Intuos pens (\$50). Each device contains a unique digital code that can be recognized by compatible software, and you can configure each physical pen as a specific digital painting tool.

We tested Tool ID with MetaCreations



WRITE ON:
Wacom Intuos
Tablet and
input tools.

Painter Classic (bundled with the tablet) and found that switching functions (from felt marker to oil brush, for example) was as simple as picking up a different pen. Intuos also ships with PenTools 3.0. In addition to some interesting paint effects, these plug-ins give Photoshop 5 the same Tool ID capabilities found in Painter Classic.

The Wacom Tablet offers a Dual Track feature that enables you to use two tools simultaneously. The actual implementation will vary depending upon the application's capabilities, but we were able to paint with a pen while using the 4-D mouse buttons as constraint keys.

The Intuos Graphics Tablet System is a winner. Increased responsiveness and a higher degree of programmability result in tools that are more expressive and more fully integrated into the digital art process than ever before.—*Luisa Simone*
Wacom Intuos Intelligent Tablet System. Street price: \$450 (includes 9- by 12-inch tablet, pen, and 4-D mouse). Requires: Microsoft Windows 95, 98, or NT 4.0 (with Service Pack 3) or later. Wacom Technology Corp., Vancouver, WA; 800-922-6613, 360-896-9833; www.wacom.com; 408 at www.pcmag.com/infolink.

When we wanted to provide a fully interactive experience and were willing to give up some environment perks for real-time interactivity, VIZ let us create animations and walkthroughs as a VRML97 WRL file, ready for distribution on the Web. (For more information on using the VRML97 plug-in included with

VIZ, see the sidebar, "MAX and VIZ do VRML, Too.")

VIZ provides a good assortment of tutorials and documentation, including a video. We found VIZ easy to use for many 3-D modeling and animation tasks and well optimized for architectural drawings, interior design plans, or site studies. If you are ready to communicate your ideas by moving from 2-D elevations to photo-realistic stills and animations, you should be working in 3D Studio VIZ R2.

3D Studio VIZ R2. Direct price: \$1,995. Requires: 64MB RAM, 200MB hard disk space, Microsoft Windows 95 or NT 4.0 or later. Kinetix, 800-879-4233, 415-547-2000; www.ktx.com; 407 at www.pcmag.com/infolink.

We imported a scene created in Platinum Technology's Cosmo Worlds into MAX and exported it with the default settings. The file exploded from 105K to 3,490K. By setting the export to no indentation and to use *ngons* rather than triangles, it was reduced to 763K, of which 711K represented MAX's conversion of 24 words of VRML97 text to 3-D text. Some features weren't imported at all, including navigation and anchor links. Interactive animations were either totally lost or distorted, and we needed to contact Kinetix tech support for a bug fix. When importing and exporting more than geometry between VRML97 and MAX/VIZ, understand the nuances to keep those small and make the scenes interactive.—*LVS*

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First Looks

VIDEO CAPTURE CARDS

Movies Made Easy

The Matrox Marvel G200-TV makes capturing video and creating sophisticated videos simple.

By Jan Ozer

Videographers (and wannabes), rejoice! There's finally a product that lets you create videos for distribution on tape, CD-ROM, or over the Internet without a Ph.D. in computer science or cinematography. The Matrox Marvel G200-TV (\$300 street) also has TV output and pretty good 2-D and 3-D acceleration to boot.

Matrox markets the Marvel as a "15 in 1" graphics solution for 2-D acceleration, 3-D gaming, and DVD playback, but number one on the list is video editing. This focus, plus the product's groundbreaking software bundle from Avid Technology, convinced us to center our tests around digital video production.

The board features the new MGA-G200 graphics chip with a 230-MHz RAMDAC, 128-bit bus and 8MB of SRAM. You attach the supplied video cables through a modem-size breakout box connected to the graphics card via a custom cable.

INSTALLATION

Matrox eases installation with a poster-size quick install guide and a QuickConnect software utility that verifies audio/video input and output connections. Most users should have the hardware up and running in minutes.

Marvel captures in M-JPEG and 8-, 16-, and 24-bit RGB in a variety of resolutions, but its maximum M-JPEG capture rate is a relatively low 3.1 MBps, which typically doesn't bode well for video quality. To measure this, we captured video from a DV camcorder and compared Marvel's footage to the original frames captured with a FireWire device.

Other than a very slight loss of detail visible only upon mag-

nification, Marvel's frames were virtually identical in color and clarity—remarkable given the capture data rate. To test performance, we captured a 10-minute segment on a 350-MHz Pentium II PC, and the Marvel did not drop frames nor lose any audio/video synchronization.

AVID CINEMA, FINALLY

Matrox complements the Marvel's impressive hardware capabilities with Avid Cinema, introduced for the Macintosh in 1997 and long awaited on the Windows platform.



STAR QUALITY: Avid Cinema's intuitive interface lets even novices create polished videos with titles, transitions, and other effects.

You start by selecting a storyboard from three categories (home, school, or business), with specific storyboards for company overview, birthday parties, and the like. In essence, these storyboards play the role of director, telling you what to shoot and how to edit. This helps businesses produce more polished videos, and home users can create vacation videos that are actually worth watching.

Of course, you can edit any storyboard, create your own, or even work without one. You can

also print the storyboard to use as a guide during filming.

Cinema's capture screen contains a quarter-screen, real-time preview window and a list of shots from the storyboard. To associate a clip with a storyboard shot, you click on the clip in the list, roll tape to the clip starting point, and capture it using VCR-like buttons.

When you start a project, you choose a quality setting that sets capture resolution for all clips (352-by-480 for good and 704-by-480 for best, both at 30 fps). Cinema provides an audio meter and volume control to ensure proper audio levels, but you



when applied. Operation is snappy (a 3-second cross-dissolve took about 1 minute). Titles are previewed in real time but must be ren-

dered before writing the video back out to tape.

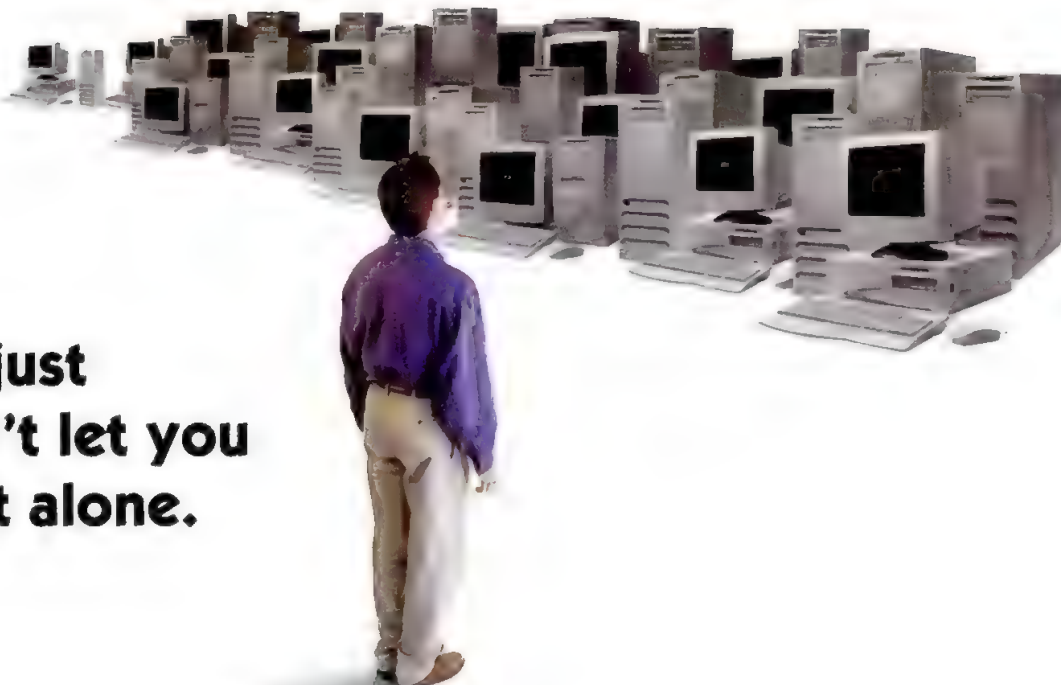
Cinema uses Matrox's Cut List editing to write the video back to tape from the timeline, allowing the program to create movies of virtually unlimited length. During our tests, we created a 15-minute video with 17 separate video segments, 9 titles and 5 ancillary audio tracks, which Cinema wrote back to tape without a glitch.

Visual quality at the best setting was excellent, though we did notice some artifacts in video produced at the good setting. In addition to output to tape, you can also output for Internet, CD-ROM, or hard disk presentations in AVI, QuickTime, or RealVideo format.

Though extraordinarily simple to use, Cinema isn't perfect, and its zeal to conceal details from users causes some suboptimal production decisions. For example, Cinema's reliance on the dated Cinepak codec is misguided, since both Indeo 5.1 and MPEG-1 provide much better quality. In addition, users will likely be frustrated by the lack of time codes on the timeline.

That said, Cinema is the perfect complement to the high-performance and excellent output quality of Matrox's hardware. And Matrox has created the most exciting video-editing package we've seen to date.

Matrox Marvel G200-TV. Street price: \$300. Requires: 166-MHz Pentium II with AGP, 32MB RAM, 300MB hard disk space, Microsoft Windows 95 or 98. Matrox Graphics Inc., Dorval, Quebec, Canada; 800-361-1408, 514-822-6320; www.matrox.com; 409 at www.pcmag.com/infolink.



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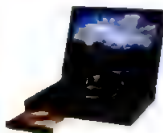
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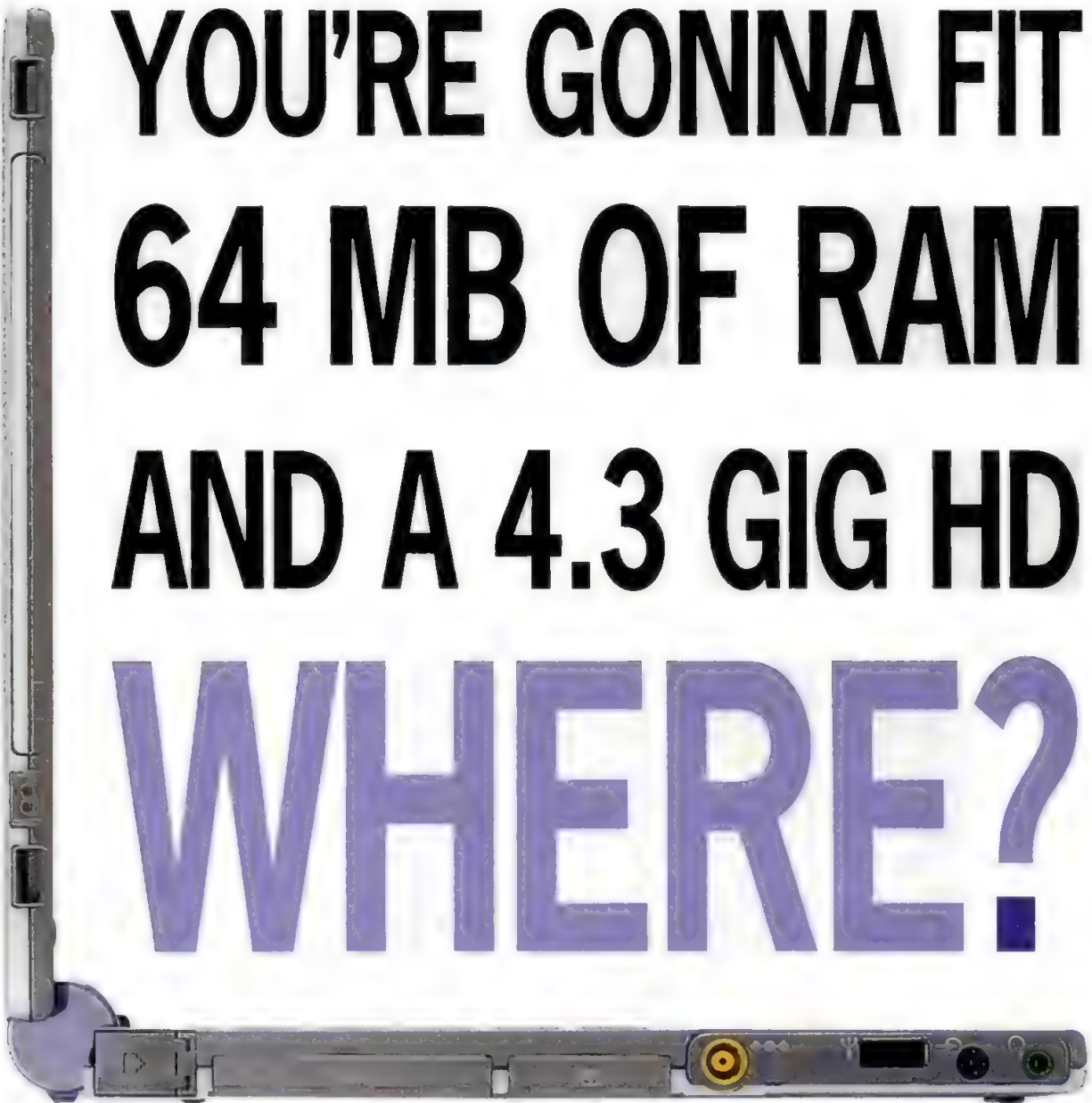
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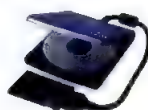
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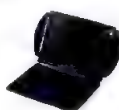
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First Looks

HOME PC

Digital Image Central

The innovative HP Pavilion 8395 home PC and Multimedia Hub will bring out the video producer in you.

By Carol Venezia

Are you itching to try your hand at PC-based digital video production? Do you consider yourself hopeless because your VCR constantly flashes 12:00? Well, help is on the way from Hewlett-Packard, with its HP Pavilion 8395 PC (\$2,400 street, without monitor). Not only does this PC provide plenty of horsepower with a 450-MHz Pentium II CPU, 128MB of SDRAM, and a 10.2GB hard disk, it also features a creative hardware and software bundle that makes digital image production both easy and fun.

The Pavilion's mini-tower may look ordinary, but take a closer look and you'll find some unique features. Up front, in ad-

dition to a 2X DVD-ROM drive, there's a serial digital camera port. Around the back are ports for composite and S-Video in and out, as well as the usual serial, parallel, and USB connectors.

What makes this package truly easy to use is the HP Multimedia Hub. On one side, there are two sets of labeled connectors (one for input, one for output) for audio, S-Video, and composite video. And on the other side, you'll find joystick, USB, and serial ports.

You'll also find a great selection of software to augment this

image-focused hardware. The company preloads MGI Video-Wave SE+, Microsoft's PictureIt! 2.0, as well as its own HP Home Video Editor, so you can work easily with both still images from your digital camera and video from a camcorder or other source. To test-drive the DVD

had a tendency to shimmer and shake, particularly during high-action scenes viewed full-screen.

On our benchmark tests, the Pavilion performed competently but didn't burn up the charts. Its Winstone test score of 28 puts it on a par with the fastest 400-MHz PCs from our roundup of May 26, 1998. Its 3D WinMark score of 596 is good but was about 15 percent lower than the top 3-D performers we've tested.

The HP Pavilion 8395 puts the true meaning of "home" back in home PC.

HP Pavilion 8395 PC. Street price: With 450-MHz Pentium II CPU, 128MB SDRAM, 10.2GB hard disk, DVD-ROM drive, \$2,400; 17-inch HP Pavilion

Color Display, \$500. Hewlett-Packard Co., Cupertino, CA; 800-724-6631; www.hp.com; 412 at www.pcmag.com/infolink.



CAMERA READY: The front of the HP Pavilion 8395's mini-tower features a digital camera port (inset).

player, HP includes "Africa the Serengeti" on DVD. We found the DVD image quality acceptable, although moving images

on our office printer.

Perhaps because pcTelecommute is a collection of communications tools, it sometimes feels disjointed. For instance, when connecting to the office with a modem, each client module dials separately. As a result, if you want to transfer some files, then synchronize others, you must disconnect the first application, then reconnect using the second.

In spite of pcTelecommute's rough edges and the fact that most of its tools are available in other stand-alone programs, having them all in one place is undeniably handy.

pcTelecommute. Street price: \$100. Requires: 8MB RAM, 35MB hard disk space, Microsoft Windows 95, 98, or NT 4.0 or later. Symantec Corp., Cupertino, CA; 800-441-7234, 541-334-6054; www.symantec.com; 411 at www.pcmag.com/infolink.

UTILITIES

Home Work Utilities

Symantec's pcTelecommute packages all the utilities you need to make working at home more productive.

By David Haskin

Telecommuting is becoming increasingly popular, but this perk is not without peril. What if you forget an important file at the office or need to synchronize files that you keep in both locations?

Symantec Corp.'s pcTelecommute (\$100 street) is a collection of tools for home workers. It includes a scaled-down version of pcAnywhere for operating your office computer from home and tools for transferring and synchronizing files between your two PCs. pcTelecommute comes with fax software based on Symantec's WinFax PRO, which can dial your phone, and if your modem supports caller ID, screen calls.

Other tools include a program that creates editable logs of your

at-home work activities, such as calls you make and receive and files you transfer or synchronize. A book on telecommuting is included, as well as a line splitter to connect your modem and phone to the same jack.

Setup is simple:

Install the server portion on your office computer and a client portion on your home PC. A series of wizards walk you through the configuration process on both PCs. You can connect to the office with a standard dial-up connection or dial into a corporate network using RAS.

pcTelecommute's modules are reasonably powerful and can, for instance, clone directories from one system to another and synchronize both individual files and entire directories. The software compresses files so that, on our tests, transferring about 2MB over a 28.8-Kbps modem connection required only about 7 minutes. We were also able to transfer a file from a remote location to the office and then remotely print it out



REMOTE CONTROL: pcTelecommute lets you view and manipulate your office computer remotely.



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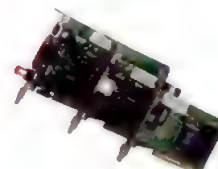


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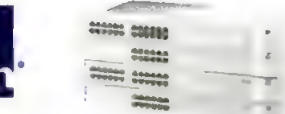
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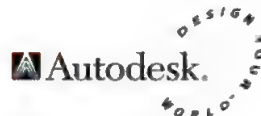


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First Looks

INTERNET ACCESS

Surfing via Satellite

Hughes Networks Systems revamps its DirecPC offering with an improved, understandable pricing structure.

By Frank J. Derfler, Jr.

The DirecPC Internet-by-satellite system has been on the market for over a year. But although its 400-Kbps download speed and easy installation are appealing, Hughes Networks Systems gave the service a pricing scheme that nobody understood or wanted.

DirecPC 2.0 is a new release with pricing you can understand and love. You can purchase the DirecPC dish and PCI card receiver for about \$200 after rebates. Hughes offers three levels of pricing for monthly service: \$29.99 for 25 hours, \$49.99 for 100 hours, and \$129.99 for 200 hours. (Prices include both ISP service and an e-mail account.)

Setup is easy: Plug in the PCI card, load the receiver drivers,

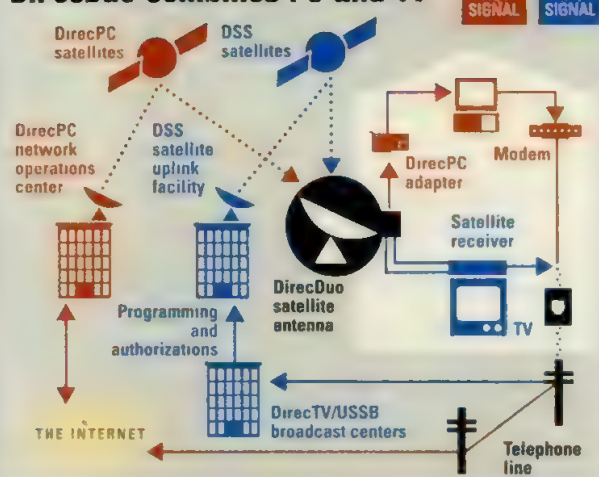
and install the dish on your roof.

During file transfers, we experienced download speeds that theoretically exceeded the speed of the 400-Kbps satellite link. The DirecPC satellite ground station has high-speed links to the MAE East Internet junction, so if you have a choice, select download servers on the East Coast, regardless of your location.

We do have some complaints about the software, however. The DirecPC driver has to separate your incoming and outgoing IP traffic. An off-line reader can download data during off-peak hours, but it occasionally froze our system. The company hopes to solve the problem with the upcoming Version 2.01.

Hughes is currently dogfighting with some users over its Fair

DirecDuo Combines PC and TV



Access Policy implemented in software, which limits downloads. Hughes claims the limits prevent abuse and commercial resale of the connection. In two months of heavy Internet use on a three-node LAN, we never saw the limitation.

Minor issues aside, the new DirecPC 2.0 pricing scheme has

turned this Internet satellite service around 180 degrees. It's fast, useful, and affordable.

DirecPC 2.0. List price: \$299. Requires 32MB RAM, 20MB hard disk space, Windows 95, 98, or NT 4.0. Hughes Network Systems, Germantown, MD; 800-347-3272; www.direcpc.com; 405 at www.pcmag.com/infolink.

NETWORK HARDWARE

Roam if You Want To

BreezeCOM brings out the first 802.11-compliant wireless networking system, BreezeNET PRO.11

By Les Freed

We have glimpsed the future of networking, and it is indeed wireless, but it's also expensive. The little piece of the future we're talking about is BreezeCOM's new BreezeNET PRO.11 wireless networking system. The PRO.11 is based on the IEEE 802.11 wireless LAN standard, which has been in the works for several years.

BreezeCOM offers wireless products for both in-building LAN and building-to-building LAN bridging. We tested the AP-10 PRO.11 Access Point hub (\$1,495 list) and the SA-PCR PC Card LAN interface card (\$565 list). Like all IEEE 802.11-compatible products, BreezeCOM PRO.11 uses Fre-

quency Hopping Spread Spectrum (FHSS) radio technology, operating in the unlicensed 2.4-GHz radio band.

The AP-10 connects to your existing Ethernet LAN and provides LAN-to-rover communications for several wireless clients. The SA-PCR installs in any Type II PC Card slot and provides a link between the laptop and the AP-10. With a single AP-10, laptops have a roam capacity as wide as a circle of about 300 feet in open space

or about 150 feet in a traditional walled building. If you need to cover a larger area, you can use multiple AP-10 units scattered around the building, but each AP-10 must be connected to the Ethernet backbone LAN.

We installed the AP-10 on our test LAN and an SA-PCR card in both a Compaq and an IBM notebook. If you'll be using more than one AP-10, you must temporarily connect each

AP-10 to a PC to configure the units to work together. The AP-10's management interface operates through an RS-232 interface using a cable provided with the unit. You can assign each AP-10 its own IP address, and subsequent reconfiguration can be

done over the LAN via SNMP. The SA-PCR cards install just like other Ethernet cards, so no special software is required.

Our test setup performed flawlessly. We moved both laptops around the building with no loss of signal, even when we moved them behind a steel-reinforced concrete block wall that had killed other wireless systems we've tested. We measured single-station throughput at about 2.7 Mbps (close to the promised 3 Mbps).

The only downside to BreezeNET PRO.11 is the price. At \$565 per PC, the SA-PCR PC Card is about \$100 more expensive than Radio-LAN, which offers a similar—but proprietary—system with full 10-Mbps Ethernet speed. **BreezeNET PRO.11.** AP-10 Access Point: \$1,495. SA-PCR PRO.11 PC Card: \$565. BreezeCOM Inc., Carlsbad, CA; 760-431-9880; www.breezecom.net; 406 at www.pcmag.com/infolink.



First Looks

UTILITIES

A Powerful Four-Pack

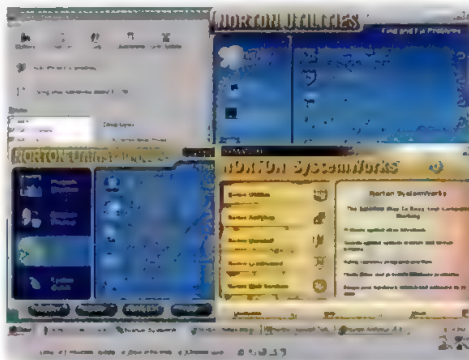
Norton SystemWorks bundles four popular utilities that work together better than standalone versions.

By Barry Simon

Taking a cue from the success of Microsoft Office, Symantec has released Norton SystemWorks 1.0 (\$100 street). This suite of utilities includes Norton Utilities, Norton AntiVirus, Norton Uninstall Deluxe, Norton CrashGuard and a six-month subscription to Norton Web Services.

Except for Norton AntiVirus (see the First Looks review "The New Norton AntiVirus 5.0," October 20, 1998), the components of SystemWorks are based on major versions that are six months to a year old. But there's a single install

and uninstall, and glue has been added in a few places, which makes the utilities work together.



BULLETPROOF: Norton SystemWorks includes AntiVirus, Crash Guard, Uninstall, and Utilities.

If Norton System Doctor (which is a part of Norton Utilities) is monitoring your free

disk space and it becomes low, System Doctor offers to run the more thorough File Cleanup from Uninstall Deluxe instead of the disk cleanup in Norton Utilities. You can also make a single set of Rescue Disks that combines the ones from Norton Utilities and Norton AntiVirus.

Integration is lacking in some areas. For example, each component has Live Update, a way to check for program updates over the Web. The main SystemWorks panel can launch a sub-panel that places all the Live Updates in one place, but there's no single button to check all the products at once. And the suite places four different icons in the notification area instead of one.

Taken together, SystemWorks has an impressive array

of features, including system monitoring, crash protection, registry editing and tracking, install monitoring and uninstall, antivirus protection, and online tracking of third-party updates. Ironically, what's missing is the kind of file organization and desktop enhancements that made Norton Desktop the leading Windows 3.x utility.

SystemWorks is just the opening salvo in what is likely to be a drawn-out battle for your utility dollars. Network Associates and Mijenix have both announced they'll be releasing utilities suites as well. Users will only gain from the competition and from the integration.

Norton SystemWorks Version 1.0. Street price: \$100 (\$69 competitive upgrade). Requires: 16MB RAM, 95MB hard disk space, Microsoft Windows 95 or 98. Symantec Corp., Cupertino, CA; 800-441-7234, 408-253-9600; www.symantec.com; 411 at www.pcmag.com/infolink.

PERIPHERALS

Direct Digital Printing

CamPrint takes the PC out of the picture by printing photos right from your digital camera.

By Bruce Brown

Syntran Color Imaging's CamPrint (\$150 street) lets you print digital camera images directly to a color printer without a PC connection. But this hardware/software solution provides a limited range of print options and is no match for the capabilities of photo-editing software. You can use the CamPrint as a fixed peripheral to your desktop printer or as a portable adapter for photo printing on the road. Output color quality, however, is poor.

The CamPrint is compatible with many digital cameras from Agfa, Epson, Fuji, Kodak, Olympus, Pretec, and UMAX. Color printers compatible with the CamPrint include Canon, Epson, and Hewlett-Packard

ink jet models (for a full list see www.symantec.com). Calibration to the connected printer is automatic; DIP-switch settings are not required.

An AC adapter and two standard printer cables are bundled with the CamPrint. One cable connects the CamPrint to the printer, and the second connects the included Centronix auto-switch. With the auto-switch, your PC and the CamPrint can share a printer without having to switch cables. The camera connects to the CamPrint via the camera's serial cable.

The 10.8-ounce CamPrint can be packed along with a digital camera for mobile processing. Its control buttons are clearly marked: There are five for print commands, three for image op-

tions, and one for resetting the device. A two-line LCD displays messages and menus and lets you select images to print by their photo numbers in your camera. There are no adjustments for paper type or other image-quality settings.

We tested the CamPrint with the Epson PhotoPC 600 digital camera and the Epson Stylus 600 printer and found the CamPrint's printed-image color quality less than acceptable on plain paper and barely acceptable on Epson Photo Quality Glossy Film. In neither case was the output as good as when printed from the PC.

An Index print command worked well in printing all images in the camera on a single sheet. Images printed in three standard print sizes (1.5 by 2; 3 by

5; and 5 by 7-inches) didn't produce true-size output, however. Image group printing and duplicate photo printing also were inconsistent, although a mirror-image feature worked correctly.

If you need to print digital images without a PC, and don't need the highest-quality prints, the CamPrint is a nonproprietary solution for quickly converting digital images to paper without editing. So-so output quality and limited formatting options restrict the CamPrint to a convenience rather than a production-level device.

CamPrint. Street price: \$150. Syntran Color Imaging Inc., San Jose, CA; 408-573-1788; www.syntran.com; 410 at www.pcmag.com/infolink.



PRINT: The 10.8-ounce CamPrint travels with a digital camera.



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Second Looks

PHOTOSHOP 5.0

Photoshop at Work

By Lori Grunin

In the graphics community, an upgrade of Adobe Photoshop is a big event, and the release of Version 5.0 made a justifiable splash. After spending the past few months working with it, we concur with many of those who shared their opinions with us online; readers' reactions were generally positive but with a few complaints.

There are some features we feel even better about now than when we reviewed Version 5.0. For instance, the ability to edit tone curves and colors in 16-bit mode has come in a lot handier than we thought, thanks to the broader availability and affordability of high-quality 36-bit scanners. And some of us still find the implementation of the History Palette better than that of Picture Publisher. Similarly, the expanded Layer Effects have saved us a significant amount of time.

The postings showed a distinct annoyance with Adobe's pricing and product strategy, though. Namely, readers said that Photoshop costs too much and that for

the price should include most of ImageReady's feature set. We also spotted some valid gripes with the product's functionality: The new version loads more slowly and exhibits some interface glitches.

Regarding kerning and tracking features, we reported online—in response to a complaint about type rendering at small point sizes—that we found problems only at low resolutions. But another reader

pointed us to Adobe's User to User Forum on its Web site (www.adobe.com/supportservice/custsupport/forums.html).

We found a string of over 60 messages documenting problems with the product's kerning capabilities. According to many in this forum, Photoshop 5.0's automatic kerning feature produces terrible results, and manual kerning doesn't work. A Photoshop development team engineer participating in the forum stated that

auto-kerned text should be kerned as it always has been; but that there is a bug in the program with manually kerned text. Adobe is reportedly working on a fix but had not posted one at the time of this story.

We still have mixed feelings about the altered color handling. It's far more complex than before—Adobe supplies two guides specifically for training users to take advantage of the new matching system. But Photoshop 5.0 remains the best for those who need a quality, flexible toolset that's well implemented and focused on boosting the productivity of the graphics professional.



V.90 MODEMS

Upgrade Carefully

By Steve Buehler

The computer industry truism that "Early adopters work out the bugs in any new products" is biting a lot of people who are making the switch to new V.90 modems.

The promises of faster speed and full interoperability should mean the decision to upgrade is a no-brainer. But remember what happened when 56K (x2

and K56flex) modems rolled out: Only about half the people who upgraded came through unscathed and with better throughput, and anyone now jumping to V.90 is running at about the same odds.

For a lot of users, the most difficult part of this upgrade is that there are no guarantees. Many readers reported positive experiences, but it's impossible to tell beforehand whether your V.90 upgrade will give you anything additional.

According to Dataquest, about 20 to 25 million people now have access to V.90 POPs through their ISPs; AOL is now boasting 100 percent V.90 compatibility. ISPs are getting better about helping users work through problems, but again—there are no guarantees.

The best strategy is to find out what equipment your ISP has and what its recommendations are. Then buy your modem from a dealer willing to accept a return if you can't get the device to

work—and if this does happen—try another modem from a different manufacturer.

If you're considering a flash upgrade for your current modem, realize that it's usually not reversible: You can't go back to your old 56K firmware after you've upgraded. Some readers have reported slower speeds



with V.90s, and connection-completion rates often drop.

The V.90 standard has been approved and should be ratified near the end of this year. Check www.v90.com for the latest information and links to manufacturers' Web sites.

After ratification, the industry will have a harder time selling modems that don't interoperate at the higher speeds, and users will be able to eliminate a lot of the trepidation about whether they'll see any increase.

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Tell us what you think...How do you like the new products you're using? Second Looks is your forum for feedback. Join us online to tell us about your experiences. We discuss a different new product every week and summarize your comments here. Below, see whether users think the upgrade to V.90 is worth the risk.

USR x2 Upgrade to V.90 I recently upgraded my internal USR x2 modem to the V.90 standard with the upgrade listed at the Dell support site. Since then my connection speeds to AOL have dropped from around 46.6 Kbps to anywhere between 24 Kbps to 37.4 Kbps (rare). It seems that either the upgrade is not ready or AOL does not fully support it somehow. What's up?

—J Hoff

V.90 Upgrade I have a USR 56K modem that was x2 now upgraded to V.90. Unlike some of the other responses posted online, my connect speed went up from 44 to 46K to 48 to 50K when I upgraded. So far I am extremely happy with the V.90 standard.

—Dwayne Scribner

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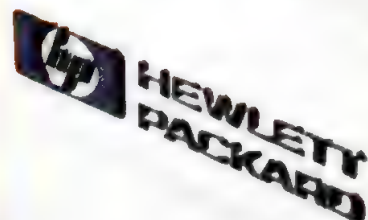
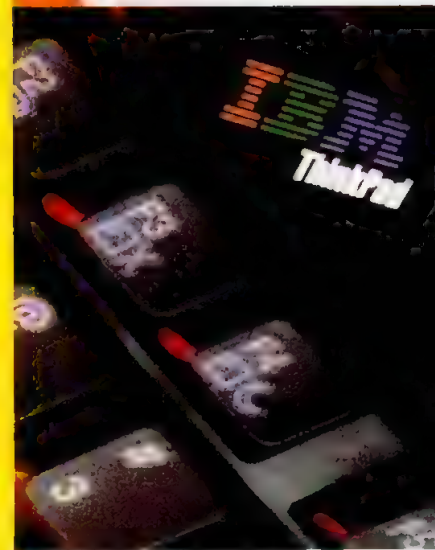
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The USB Debacle

The Universal Serial Bus was supposed to save us from the PC's age-old serial-bus problems: too few ports, too many interrupt conflicts, too slow a speed. The USB spec is ambitious, and it's well thought out. It allows for speeds up to 12 megabits per second and

up to 127 devices connected by simple cables and hubs, so wiring things incorrectly becomes next to impossible. The machine can supply up to 500 milliamps of operating current to the peripherals, eliminating extra power supply wires for many devices. We've been buying machines with USB ports for more than two years now, and the promised peripherals were always just around the corner. Now, in the last quarter of 1998, they're finally here.

I've been championing the USB cause from the beginning; the technology is a long-overdue solution to many usability problems and a breath of fresh air for the peripheral vendors. It promises to make installing video cameras, scanners, and many other peripherals much easier. It also creates the possibility of new peripherals, such as USB speakers, which keep sounds in digital form the entire time they're in the PC.

So what's the problem? For starters, you need to upgrade to Microsoft Windows 98. Although there was a second version of Windows 95 floating around that had USB support, as a practical matter Windows 98 is essential in order to have the latest USB drivers and device support.

Then there are the peripherals and their drivers. I have several machines running Windows 98 and a table full of USB peripherals. Each day I spend with them is an adventure into the unknown, an exploration of the far reaches of frustration. Any one device has a pretty fair chance of working well. A second USB device is likely to bring the show to a quick halt or so degrade the performance of the first that it becomes useless.

For instance, the Storm Technologies/Logitech USB scanner is a dandy little device that seems to fulfill the USB promise: It has one wire, no power supply, self-installing drivers, and automatic wake-up of the scanning software, and it's even a decent scanner for light desktop publishing and Web work. The way the driver is implemented, however, makes the scanner a bandwidth hog. It needs to go back to USB kindergarten and learn how to share nicely. The scanner works through some USB hubs

but not others. Is this a Storm/Logitech problem? A hub design problem? Who knows?

With USB on laptop computers, I've seen an interaction between various suspend and power-down modes and the USB drivers. On reawakening, some machines

forget that a USB device is there. The quick fix is simply to unplug and replug the device, which normally causes it to reload the drivers. In many instances, however, the machine demands the Windows 98 CD-ROM in order to load the drivers from scratch.

The installation procedure for many of these drivers is apt to confuse inexperienced users. Windows informs you that it has detected an unknown device and is searching for the driver. Although you have to do little more than click 'OK,' you may think you're installing the same driver several times before it finally takes. If you look at the filenames that the machine is looking for, however, you'll see that Windows is loading additional drivers, but each one is preceded by the "unknown device" message. There's no progress bar or other indication of how the install is going.

The Altec Lansing USB speakers, for instance, require three drivers before they'll operate, plus the download and installation of a control panel applet. Once installed, however, they work beautifully. They sound great, and any adjustment you make on the speakers (volume, bass, treble) shows up on the control panel.

Likewise, adjustments to the control panel take effect with the speakers instantly. They're relatively immune to assaults by other USB devices; I've heard only one glitch since using them. But when I tried to demo the speakers to fellow columnist Bill Howard the other day, Windows made me reload the drivers and still couldn't find one of the DLLs. So he'll have to take my word on how good they sound.

I could go on chronicling USB glitches for several more pages, but my fervent hope is that manufacturers will get together and have some serious plugfests before they unleash more devices on the public. Let's get the problems fixed—and fast. **PG**



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Microsoft Rewrites Its Own History

The recent assertions that Microsoft had its current Internet strategy in play as early as December 1993 are utter nonsense, although the company was apparently beginning to become aware of the Internet in early 1994. Microsoft had an executive retreat

two days after Netscape was founded, on April 6, 1994, but there's no evidence that this led to any serious effort.

I say this because if you follow Gates's column in *The New York Times* and his speeches, which are posted on Microsoft's Web site, you'll notice he seemed nonplussed by the Net until late 1995. By early 1996 he became a fanatic.

It all began with two memos that floated around the company in early 1994 proclaiming the Net to be the next big thing. These memos by (then) genuinely low-level employees are interesting, but they are hardly convincing evidence that Microsoft took the Net seriously. Shortly after the April 6 retreat, Microsoft began talks to license the browser already developed by Spyglass. It was as if the company wanted to have something ready just in case. But if Gates had sincerely considered the Net important, then Microsoft would have developed a browser in-house in no time at all. Version 1.0 browsers were not complex code.

Over seven months later, despite the fact that most of the world was turning toward the Net, Gates gave his fanciful "Information at Your Fingertips" speech at Fall Comdex. Throughout the speech, he mentioned the word *Internet* once—and only in passing. He instead harped on how CD-ROMs would rule the earth.

Throughout much of 1995, Microsoft was still clueless, at least in the executive suites. The company was banking on the success of MSN, an online service. Peter Lewis's column in *The New York Times* on February 26, 1995, on "making Microsoft the king of the online universe" discussed Microsoft's game plan, as implemented by MSN's honcho at the time, Russ Siegelman. The litany was that "tens of millions of personal computers around the world that now use Microsoft software will be connected to a network that both embraces the global Internet and rivals it in size. Although on-line information competitors like America Online, CompuServe and Prodigy have taken nearly a decade to amass an estimated total of six million subscribers, Microsoft hopes to overtake them all within a year of its scheduled launch in August."

At that time, MSN—not a browser—was going to be built into Microsoft Windows 95. Everyone was freaked about Microsoft getting into the online business. The same *Times* column quoted newsletter pundit Jeff Tarter as saying, "My guess is that the Internet will vanish almost

as quickly as it surged into prominence. I think The Microsoft Network is going to be the Internet of 1996." This kind of nonsense was swallowed whole by Microsoft executives. There was no way the company was going to take the Internet seriously!

Earlier the same month, Bill gave a speech to his old high school. He was still proclaiming the CD-ROM revolution, twice referring to the Internet as "that thing called the Internet," as if it were an inconsequential bug or something.

It was August 1995 when things changed. Netscape became public, and Jim Clark became an instant billionaire. More important, on August 8, 1995, the front page of *Forbes ASAP* read "Netscape's Marc Andreessen: George Gilder thinks this kid can topple Bill Gates." This was during the peak of Gilder's cult of personality. When he spoke, people listened.

Microsoft must have freaked at this turn of events. Within months, the Internet was emphasized in every Gates speech. MSN's flop just made him more frantic. This was combined with dubious assertions by Netscape execs about burying Microsoft somehow. Talk soon emerged about making an OS from the browser.

Quite a stretch, but apparently not enough to keep Gates from taking it seriously.

On May 30, 1996, Gates spoke at M.I.T., and the dream of the CD-ROM revolution and his conception of the Internet and browser technology had changed drastically. Here he was freaking out over another imagined threat: "Is Netscape an operating-system competitor? Absolutely, even though what they sell today is not an operating system; it is going to be an operating system."

Over two years have passed, and I'm still waiting for this imaginary Netscape OS. It was bull, and so is Microsoft's attempt to rewrite history.



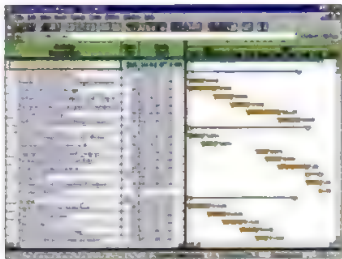
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Inside Track

Breaking Ranks Dept.: It's hard to say what's triggering the schism between Intel and a few of the top computer makers, but the conflict is coming to a head with two proposals for a new PCI bus. Compaq, HP, and others are promoting the PCI-X, which pumps the speed of the bus to 133 MHz. Intel is working on a **new architecture**, currently dubbed the NGIO (Next Generation Input Output), which is expected to add **main-frame-class I/O** (a.k.a. channels) to the desktop. But the backward compatibility of the NGIO will supposedly be negligible, and PC makers don't want to switch gears yet again. It's too costly. PCI-X will offer a cheaper, quicker fix.

In the meantime, since PC vendors seem to be **moaning about PCI bottlenecks** in the server arena, Intel may offer an upgrade to the PCI bus, but whether it'll be PCI-X or not remains to be seen. Whatever the case, look for a new architecture (again!) to emerge in the next 24 months. This runs counter to the classic PC model of faster, cheaper, smaller. This strategy seems to be faster, faster, faster.

Meanwhile, **on the faster, cheaper, smaller treadmill**, Cyrix is rolling out a reduced-voltage version of the MediaGX, which was quickly picked up by Casio for its **micro-notebook computer**. This machine is expected to be in the Libretto class of **handbag computers**, also known as the "who needs this?" class. NEC has one coming out called the **Mobio**. I believe the Mobio will support a full Windows OS, as opposed to the slew of new Jupiter-class "who needs this?" machines running Windows CE.

I have **never been convinced** that this class of machine will succeed. First of all, we're more plugged in than ever before, and these machines (all vaguely reminiscent of the **defunct Gateway Handbook** mini-notebook) don't make things easier. I could imagine using the Gateway Handbook for emergency e-mail or to retrieve some data in a pinch. But now that we get a ton of e-mail, we need real keyboards. **Nobody** wants to go back to the office knowing his work is all backed up because he could only type "I;l gert bsack ti u asAp,jophn."

Some apologists cite the success of the **Sharp Wizard** and such machines, failing to note that their users (at least the smart ones) drifted toward the 3Com PalmPilot. While companies such as Casio hope they can compete in this market, I expect it won't happen, because there is no market.

While on the Subject of Diminutive Machines Dept.: Casio should look in its own backyard for **trendy new computers**; I mean it should look on its wrist. The **computer-in-a-watch** phenomenon is closer than you think. We were approaching this concept with the

*Cyrix is rolling out a
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needs this?" class.*

Timex/Microsoft watch, but the new Ruputer comes closer still. Running a DOS-type OS (W-PS-DOS), the machine is available now in Japan. The Ruputer **looks like a normal watch**. But when it's plugged into a cradle, you can hook up a keyboard and screen and suddenly be computing as if with a desktop.

The Ruputer was **developed by Seiko**, and the company refers to it as a "wearable personal computer for mobile professionals." The price ranges from \$290 to \$370. The high-end Seiko MP120 has 128K of main memory, 512K of ROM, and **2MB of flash built-in**. The backlit, dot matrix screen is 102 by 64 pixels and is water-resistant. There's a built-in RS-232C port, and **also an IR port!** Batteries should last four months.

The docking station incorporates a CD-ROM drive and includes a disk loaded with applications for the little computer. Supposedly, this thing will **coordinate with Lotus Organizer and Microsoft Outlook 97**, too. This is indeed **the future of computing**. Too bad the Japanese are going to waste time making Jupiter computers. I want this! Take a look at it at www.ruputer.com.

Brand-Name Mania Dept.: Look for the sound-card companies to employ a classic brand-name strategy. Creative Labs may be a brand name to you and me, but it will never be the same as, say, Altec Lansing or Bose. Some PC companies are adopting the idea of adding such brand-name speakers to their machines in the same way car makers added classic brand-name speakers to car stereos.

The next logical step is to bring out **sound cards** with the same classic brands attached. If a sound card had the Polk Audio or Cambridge SoundWorks name, it would soon be the hot ticket over, say, Diamond or even Creative Labs. A lot of these companies are working on joint ventures, and some are developing a standalone strategy. I just wonder which will be first on the market.

Another new development may reverse my opinion of CMOS imaging technology. As you know, many camera companies would love to use CMOS chips for imaging, because they're **dirt-cheap compared with CCDs**. Unfortunately, the noise in the chips requires a lot of **complex filtering**, and even after that's done, the image still sucks.

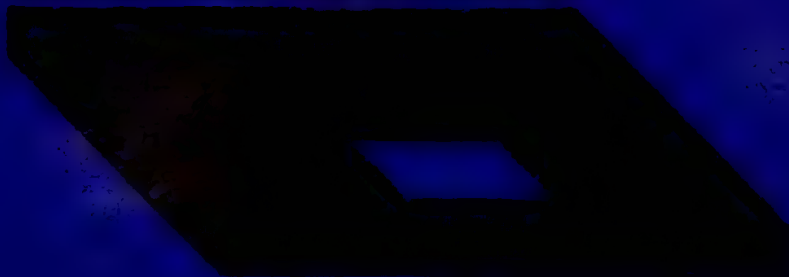
The **lure of cheap chips** is never ending, and a new development at the Jet Propulsion Laboratory (JPL) won't help. Scientists there have developed an electronic shutter incorporated into the CMOS sensor making it possible to **stop motion** and clear up the images without the use of a strobe or a mechanical shutter. This will further promote the use of CMOS in cameras, I fear. JPL is doing this research because CMOS beats CCD in its low power consumption, something needed in space probes. **PC**



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Smart Printer Tricks

Elsewhere in this issue, you'll find detailed reviews of zillions of great printers. I want to point out a couple that I think get overlooked—in a sense, the Mutt and Jeff of the printer world—and I also want to suggest a way of thinking about office printers

you may not have considered before.

Over the past three or four years, the quality of ink jet printers has improved phenomenally. Epson's first 720-dpi Color Stylus printer started the ball rolling, and now Canon, Epson, Hewlett-Packard, and to a lesser degree Lexmark are engaged in a frantic contest, pushing ink jet output quality up to a higher level than anyone might reasonably have expected, while simultaneously driving prices down to almost ridiculous levels. As a result of this intramural game, you can buy a printer today capable of astonishing photo-quality output for not much more than \$200.

Thanks to that pricing, ink jets have become the printers of choice for home PC users. Where not so long ago a slow, noisy, mediocre-quality dot-matrix printer was the home-PC norm—replaced a little later by a slow, whiny, mediocre-quality monochrome ink jet machine that probably came bundled with the PC—today's home PC users routinely enjoy astonishing color output from their slow, whiny, four-color ink jets. Except for high-end, high-speed models used mainly for printing multipart forms (such as invoices), dot-matrix machines have nearly disappeared.

But as good as \$300 to \$500 color ink jet printers have become, they're almost never seen in offices outside the home. Far too many businesses relegate ink jet printers to a kind of home-computing ghetto—usually forgoing color in the process—because they believe these small, affordable ink jet printers are somehow beneath them, or at least beneath consideration for “real business” use.

Forgive me, but that's nuts. Many of today's better mid-price color ink jets are perfectly capable of performing very well in office settings. If your office relies on one or more monochrome laser printers for most output, a high-quality, remarkably cheap color ink-jet printer can be a great addition to the office. If only one person in a small office routinely uses color (or would like to), you can set the machine up as a directly attached printer on that user's PC.

Better still, network the ink jet so that anyone in the office can use it. Networked? *Ink jets?*

Yes, and it isn't half as goofy as it sounds. Six years ago, the pricey HP 1200C showed us that a networked color ink jet printer could be a good investment as a shared tool. With built-in networking available as an option, via an HP Jet-Direct Ethernet printer-sharing card, the 1200C became a

popular tool in many offices. Unfortunately, the 1200C (and its even higher-quality successor, the 1600C) cost twice as much as many of today's great small laser printers (and five times as much as today's far better color ink jet printers). So the adoption of shared color ink jets in business was delayed, as we proliferated successive generations of fast, lower-cost, networkable monochrome lasers throughout our offices.

After all, real men don't use color. Or so we thought, ignoring the color revolution (TV, newspapers, Web pages, and color copiers) all around us.

Today we know that was foolish. And today you can buy one of the best color ink jet printers ever made, the Canon BJC-5000, for \$250 (street). This wide-carriage machine takes paper up to 11 by 17 inches, uses Canon's seven-color printing process for stunning quality, and adds the company's “P-Pop” technique of prespraying microscopic drops of a solution on the page, which dramatically increases smear resistance. It can even use two fat black-ink cartridges simultaneously, for extremely good 6- or 7-ppm monochrome output.

Consider that for a minute: \$250 for a printer that can meet many and maybe

all of the needs of most small- to medium-size businesses. I'm not going to try to persuade you to dump your laser printers for monochrome output: Lasers still have an edge over the BJC-5000 in print quality—though it's a *small* edge. You would not believe me anyway if I told you a BJC-5000 was all you needed. You're hooked on laser printers' quality and speed. Me too.

But consider the productivity and economy of a BJC-5000, or another of today's great low-priced and compact color ink jet printers, as a locally attached device for people who need to turn out good color routinely—for reports, proposals, flyers, whatever. Pretty good for \$250, eh?



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Now consider *networking* that printer, so those on your LAN who have only an occasional need for color can use it too. I know networking a \$250 printer sounds silly. But Axis, whose affordable, pocket-size network print servers have saved my bacon more than once, worked with Canon to produce the small Axis Print Server 140 (\$130 street), which lets you network Canon ink jet printers quickly, easily, and affordably.

Think about it: a shared, high-quality, seven-color-output, tabloid-size, reasonably fast color printer on your LAN—for \$380? See what I mean?

A second unknown but wonderfully useful color printer, which is very much at the opposite end of the size/weight/price scale from the BJC-5000, is the Tektronix Phaser 380. This behemoth, a Bunyonesque big brother to Tek's ground-breaking 340, 350, and 360 thermal color printers, produces superb full-bleed 11- by 17-inch output with the same 600- by 300-dpi quality we've come to associate with Tek's smaller machines. You can even duplex-print those 11- by 17-inch pages manually—though I still haven't figured out how the printer refeeds those waxy-ink pages without melting and destroying the images already laid down on the first side.

Don't count on putting a 380 in your cubicle. At 220 pounds, and with a 24- by 24-inch footprint and a 22-inch height, it demands room, its own stand, and almost, as my assistant says, its own ZIP code. But it's worth its price (\$10,000 street), size, thermal load on your HVAC system, and clunky noises in many corporate settings.

Tek positions the 380 as a proofing device for graphics arts shops. I'm sure it serves that purpose very well, but it fits equally well onto many businesses' LANs. The 380 is a fast, "big-color" box that can pay for itself quickly. Unfortunately, most of these businesses never hear of the 380, because it's aimed at the graphics market.

Even if you decide not to network one or the other of these printers, they still make a lot of sense as standalone, directly attached printers near the desks of people who need them. I'm not trying to undermine network managers' carefully laid plans for getting everyone onto networked printers, but I do hate to see people caught up in "how it's always been around here" thinking.

Printers are just tools, and using the right tool always makes sense. **PC**

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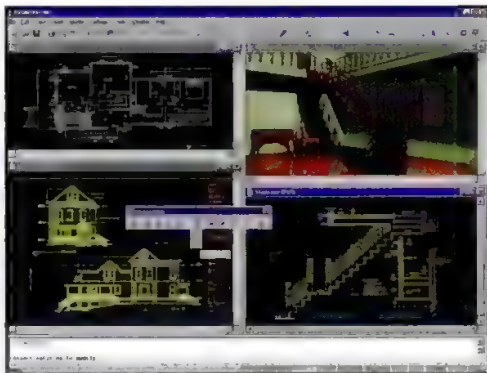
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files through version R14.01 without conversion or data loss. IntelliCAD 98 also provides support for AutoCAD commands, Autodesk AutoLISP programs, menus, dialogs and other legacy tools. Plus, it already runs over 100 AutoCAD applications from third-party developers, such as Eagle Point Software, Intergraph Corporation and Hitachi Software.



So don't confuse IntelliCAD 98 with a non-customizable, scaled-down version like Autodesk's AutoCAD LT. In fact,

IntelliCAD 98 offers features not available in full-blown AutoCAD—like the ability to have multiple drawings open simultaneously, and cut and paste between them. There's also complete Microsoft ActiveX support for in-place editing within popular applications, such as Microsoft Word, Microsoft Excel and Visio® Technical. And just how affordable is

IntelliCAD 98? How's \$349 sound? Pick up a copy at your nearest retailer and discover for yourself what all the talk is about. For more information call 1-800-24-VISIO, reference A454. Or see it in action at www.visio.com/tryit.

**60
DAY****MONEY-BACK GUARANTEE**

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Don't Be So Cheap

Some people want *cheap* no matter what it costs them. In the long run, you're going to pay for insisting on the lowest selling price. That's especially important to remember when you look at the ink jet, laser, multifunction, and photo printers reviewed in this issue.

In my book, the \$99 ink jet printer is a technical marvel—but still a definite no-no. It's just like the \$999 (or \$799 without monitor) PC. You get a product that works, but not as well as you're going to wish it worked. One thing that doesn't suffer too much is print quality. During our testing at PC Magazine Labs, we found that low-cost (not necessarily lowest-cost) and higher-cost printers can both produce excellent output.

Still, you're far better off with a \$1,500 PC or a \$200 printer. Let's count the reasons many \$99 printers shouldn't be on your buying list.

Three-color printing. Want to print color? You stick in the three-color CMY—cyan (light blue), magenta, yellow—cartridge. Want to print black text? Stick in the black-only cartridge. Want to print color graphics and black text? Stick the color cartridge back in and watch text form painfully slowly, because you're creating it with one shot each of cyan, magenta, and yellow.

No-black printing. Some of the sub-\$100 printers don't even include the separate black cartridge, which can run you \$30. Once you've bought that, you're pretty close to the \$150 price point of the cheapest four-color printers.

Expensive printing. Cheap printers use small ink cartridges, which jacks up the per-page cost for color graphics printing even with nominal (15 percent) coverage to as much as 20 cents. You can halve that with bigger, initially costlier printers. Then there's the hassle factor of tiny

print cartridges. They can run out of ink at any time, annoying you and possibly stranding the user, because (a) you don't have a spare cartridge around, (b) you've got it, but you don't know where you put it, or (c) you're not around, and the user isn't sure how to change the cartridge. I've found that if I'm going away on a business trip for a week and the cartridges are running low, I'll change them early to avoid the hassle of getting that call on the road: "Daddy, it doesn't print red any more."

No output tray. A few (but thankfully not many) of the cheapest printers don't include a tray to catch the printouts. Instead, the paper flops on your desk or the floor. Talk

about cheap! Longevity note: Low-cost printers have lesser paper-handling mechanisms and less durable parts.

When colleagues, airplane seatmates, and neighbors ask about low-cost printers, here's what I tell them: If you're buying for a home or small business, consider a multifunction printer, which is a printer, a fax machine that works as a standalone (without the involvement of the PC), a color (not monochrome) scanner, and a convenience copier. You'll spend about \$400 to \$500—which translates into a premium of about \$200—over the cost of an ink jet printer using the same print engine.

If you already have a lot of devices clogging up your parallel port, take a look at the handful of printers using USB (Universal Serial Bus) connections. Do test your connection thoroughly when you set it up, because although USB has been incredible in its promise, some early implementations have been flaky.

If you print a lot, think about getting two printers: a color ink jet *and* a low-cost laser. Laser quality costs only a penny or two per page, and the sheet never smears if you get it damp.

Small businesses that are planning to network a printer will need one that has its own controller. Many cheaper printers, even some selling for around \$300, use the PC as a "host-based" microprocessor.

In the context of ink jet printers and some low-cost lasers, *network-ready* simply means that the printer has an internal controller, not a slot for an Ethernet card.

When you buy, remember that a printer cable generally doesn't come with the printer, although HP is finally coming around and including one with some models. Also, for ink jets, buy a spare set of cartridges right away. You may get offered an extended warranty, but in my personal experience, either printers work from day one or they don't.

The best thing about these low-cost ink jets? The color is dazzling. On glossy paper, the best of these printers match and sometimes exceed the color quality of a \$3,000 to \$5,000 specialty printer. In little more than a decade, ink jet technology has gone from a scratchy monochrome joke to a high-fidelity, spot-on color marvel. But not at \$99. **PC**



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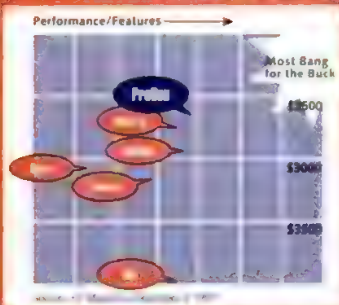
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By Alfred Poor and
Jamie M. Bsates



Competition in the printer market is heating up as vendors slash prices to protect their market shares. And the winner is you.

The news is that even a \$150 entry-level ink jet printer is now capable of producing stunning photographic prints that rival the output of printers that cost thousands of dollars just a few years ago. With personal lasers, engine speeds of 8 pages per minute (ppm) are now the norm, up from 4 to 6 ppm last year. In the multifunction arena, color printing and color scanning/copying are now more commonplace.

To help you figure out which type of printer is best suited to your particular needs, we have assembled the newest current personal printers in one convenient comparison. (By personal printers, we mean those intended for standalone rather than

shared, network use.) In this issue we test:

- 24 ink jets new to the market since our roundup a year ago, plus a returning Editors' Choice (the HP DeskJet 722C) and the portable HP DeskJet 340 that is still on the market.
- 5 photo-specific color printers, covered in After Hours.
- 14 monochrome lasers with rated engine speeds of 12-ppm or less. Half of these can accept an internal network interface card, although they are not as network-focused as the 26 network printers we tested in our May 26 issue.
- 12 printer-based (as opposed to fax-based) multifunction printers priced under \$1,000.
- 9 of these offer the four functions typically found in all-in-ones (printing, scanning, copying, and faxing); 3 leave out standalone fax capabilities.

◀ Ink Jet

With the ink jets we tested, the news is output: Image quality from many of the units is spectacular. High cost per page is the hidden gotcha.

PROS

- Low cost of entry
- Near-photo-quality color
- Near-laser-quality text

CONS

- Slow speed
- Costly consumables
- Frequent cartridge changes



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◀ Laser

Lasers are still the fastest way to get great-looking text to paper. With color becoming more popular in reports and presentations, however, a monochrome-only printer is a limiting choice.

PROS

- Great speed
- Perfect text
- Low cost per page

CONS

- Monochrome only
- More expensive to buy



◀ Multifunction

Choices in multifunction printers are getting more varied; you can pick a laser-based model for speed or an ink jet-based one for color output. Fax is going away; scanning is still a weak link.

PROS

- Instant office: printing, scanning, copying, faxing in one box
- Smaller and less expensive than separate units

CONS

- If the unit breaks down, you lose several key office functions
- The sum is often not as good as the individual parts

THINK INK

If purchase price is paramount, then look no further than the ink jets. These are by far the least expensive class of printer to purchase. In this roundup, 11 models are priced at \$200 or below—and the Lexmark 1100 Color Jetprinter comes in at an incredible \$90 after rebate. Such alluring prices have helped make ink jets the most popular segment of the printer market. According to Lyra Research, a market research firm based in Newtonville, Massachusetts, U.S. unit sales for ink jets were 11.3 million in 1997; they are projected to grow to 12.5 million this year and 15.6 million in 2000. The ink jets' gain comes at the expense of the laser market. Lyra reports that laser printer sales are about to peak, with 2.0 million units sold last year and 2.1 million projected for this year; unit sales will then trend downward to 1.7 million units in 2000.

What's more, image quality continues to improve. Canon Computer Systems offers seven-color printing for photo-specific output in its BJC-4400 (\$180) and BJC-5000 (\$250) printers, as well as its new Drop Modulation technology, an automatic resolution-enhancing process that lets the printhead place both full- and half-size dots on the same line, in all its ink jets. Epson America has pushed the resolution envelope to 1,440 by 720 dpi for most of its Stylus line. Hewlett-Packard uses *multilevel printing*, a color-layering technology that makes dot patterns in graphics and photos harder to see—or even invisible to the naked eye—which produced some of the best output we saw despite the rated 300-dpi resolution. These technologies, combined with the special glossy paper, yield output that can be mistaken for true photographic print by the casual observer.

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Manufacturers have also continued to improve text quality on plain paper. In years past, you needed special coated ink jet paper (about 5 cents per sheet) to get near-laser-quality output, and even then characters weren't as crisp and well formed as they were with lasers. Last year, Lexmark International delivered true laser-quality text in its high-end model (the Lexmark 7000 Color Jetprinter). This year, 11 of the ink jets we tested delivered excellent text quality on plain copier paper.

Ink Jet Output: Finally Arrived

We were impressed by this year's ink jet printers—even the most affordable. Here, we show photo output and text (magnified 5 times).

Cheapest Printer Lexmark 1100 Color Jetprinter



Best Printer HP DeskJet 895Cse



Speed is also improving. Although ink jets are still slower than their laser counterparts, most ink jets are fast enough for normal text documents, typically delivering 2 to 4 ppm throughput on our real-world text tests. There's even a new class of ink jet, typified by the Epson Stylus Color 850 (\$350) and HP DeskJet 2000Cse Professional Series (\$800), that is fast enough (providing greater than 5-ppm throughput on our text tests) to be networked and shared by small to midsize workgroups.

Another trend is the emergence of affordable oversize ink jets that can deliver tabloid-size (11 by 17 inches, or *B-size*) or larger output for posters, desktop publishing, marketing materials, large spreadsheets, and the like. The Canon BJC-5000 (a steal at \$250) and HP DeskJet 1120Cse (\$500) offer tabloid printing; the Epson Stylus Color 1520 (\$800) can support media measuring up to 17 by 22 inches (also called *C-size*).

Ink jet technology is not without its flaws, of course. Tops on our list of offenses is operating cost. Though you can get a good ink jet printer for about \$100 less than the least expensive laser, the price you pay for ink for each printed page (3 to 6 cents for a double-spaced business letter) is often twice that of a similar laser-produced page (1.5 to 2.5 cents). For a home printer that sees only occasional duty, the cost equation is still in the ink jet's favor. But for a business printer that

"reverse order" choice in the driver.

We also recommend that most users opt for a four-color printer, that is, one that uses cyan, magenta, yellow, and black inks (CMYK, in printer parlance) to print color documents. Color images look better, and you don't have to swap out the color cartridge for a dedicated black cartridge when you want to print text-only pages. With three-color machines, black text printed within a color document is created using the colored inks and looks gray and fuzzy. Worse, the lowest-priced units of these five—the Compaq IJ200 and Lexmark 1100 Color Jetprinter—cost less than \$100 after rebate but don't include a black ink cartridge. Adding the \$30 cartridge (which you surely need) brings your true cost into the same range as that for a superior four-color printer, such as the Epson Stylus Color 440 (\$150).

THERE'S LIFE LEFT IN LASERS

Ink jets may have lasers on the run in terms of market share, but if you need raw speed, lots of copies, and are happy with black-and-white output, a laser printer is still the way to go. As we pointed out, the cost per printed page is much more attractive and though ink jets are getting faster, lasers still deliver a speed advantage.

In fact, entry-level laser printers are getting faster. The 4-ppm engine speed of the typical entry-level laser two years ago (average price: \$370) gave way to the 6-ppm unit last year (\$340). This time around, half of the new personal lasers come equipped with an 8-ppm engine. Three of the lasers have 10-ppm engine speeds, and Xerox Corp. has a 12-ppm unit, the Xerox DocuPrint P12, for just \$700.

In addition to speed, most lasers also offer better paper handling than ink jets, as well as higher monthly duty cycles, which makes them better for high-throughput business environments. And of course, laser output is still the standard by which monochrome text is judged. All of the units we tested offer at least 600-dpi output, and half offer a 1,200-dpi mode.

Laser text

PC Mag

Typical ink jet text

PC Mag

Best ink jet text

PC Mag

sees daily use—and in a corporate environment that deploys a lot of printers—laser printers deliver the lower total cost of ownership.

Another downside to most ink jets is their limited paper-handling abilities. Most ink jet input trays can only hold a maximum of 100 sheets, and the printers don't support auxiliary trays to increase input. Personal lasers typically offer 250-sheet input capacities, and more than half of the ones we tested let you add second trays. Also, virtually all ink jets deliver your print job face-up in the output tray. This means your print jobs will be in the wrong order, with the last page on top, unless you remember to choose the

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MORE COLORFUL MULTIFUNCTIONS

Multifunction printers—those that combine printing, scanning, copying, and often faxing capabilities in a single machine—are gaining in popularity. In fact, Lyra identifies the multifunction arena as the fastest-growing market segment, with 1997 sales of 2.3 million units (more units than lasers) growing to 3.2 million units in 2000. Multifunctions are appealing because they combine all the necessary office tasks into a single, space-saving, cost-efficient device ideal for a home office or branch office that does not have an office-appliance infrastructure.

And we found that these units are improving with each generation. Color printing is now commonplace: Half of the units we tested are based on ink jet engines. Manufacturers have also added color scanning (and thus color copying) to the mix, with four of the units here offering 24-bit color scanning. Read the reviews carefully, however, because image quality in some cases lags what you could get with a stand-alone printer or scanner (with the notable exceptions of the Canon and two HP OfficeJet ink-jet products). For users who have a fax machine already, or who don't trust a multifunction, the Brother MFC-P2000 (\$400) and HP LaserJet 1100A (\$500) are both laser MFPs that forgo fax.

ACROSS THE BOARD

Whichever class of machine you've settled on, there are several factors to keep in mind as you narrow your search. Note that most of the low-cost printers here are Windows-only machines that rely on your PC to process images. If you need to print from a legacy DOS application, you'll need to go to a DOS prompt in Windows. Only 8 of the 26 ink jets we tested support DOS natively, as do 8 of the 14 lasers and 6 of the 12 multifunctions. Windows NT, OS/2, and Mac support are also not a given (see each section's Summary of Features table for compatibility listings).

We expect USB (Universal Serial Bus) interfaces to become more commonplace in 1999. In this roundup, only the HP DeskJet 895Cse Professional Series ink jet (\$400) and Brother HL-1050 laser (also \$400) offer USB connectivity in addition to the standard parallel port. And speaking of parallel ports, beware the hidden cost of the printer cable: Most printers don't include one in the box, so plan on making a stop at

Editors' Choice

- Ink jet: Epson Stylus Color 440, HP DeskJet 895Cse Professional Series
- Laser: NEC SuperScript 870
- Multifunction: Brother MFC-7150C



The best value in the ink jet category is the Epson Stylus Color 440 (\$150). This Editors' Choice delivers good output and respectable speed at a bargain price.

Home and SOHO users on a tight budget can pass on the bare-bones three-color printers and get this true four-color unit for just \$30 more. Home users serious about great color (and willing to spend more for it) should look at our honorable mentions, the HP DeskJet 712C (\$250) and DeskJet 722C (\$300). These are more expensive than other home-oriented ink jets, but their output quality and speed may be worth the extra money if you use your printer often.

For more demanding day-in, day-out business use, our Editors' Choice is the HP DeskJet 895Cse Professional Series. It was one of only two printers (the HP DeskJet 722C was the other) to receive ratings of *excellent* across the board for text quality, photo quality, and speed. A very close runner-up to the 895Cse and worthy of honorable mention is the Epson Stylus Color 850 (\$350). It's cheaper and a touch faster than the HP unit, but our jury preferred the output of

the 895Cse, so the Epson takes second place. Honorable mention also goes to the Canon BJC-5000, which delivers tabloid output for an unbelievable \$250.

In the laser category, NEC Technologies trumps the competition with a fast, robust printer priced hundreds of dollars less than its peers. With its 8-ppm engine and Adobe PrintGear processor, the NEC SuperScript 870 (\$350) was one of the quickest units on our tests. The internal NIC (\$249 list) and extra input tray (500 sheets for \$169 list) mean this printer can grow with your business to become a shared laser.

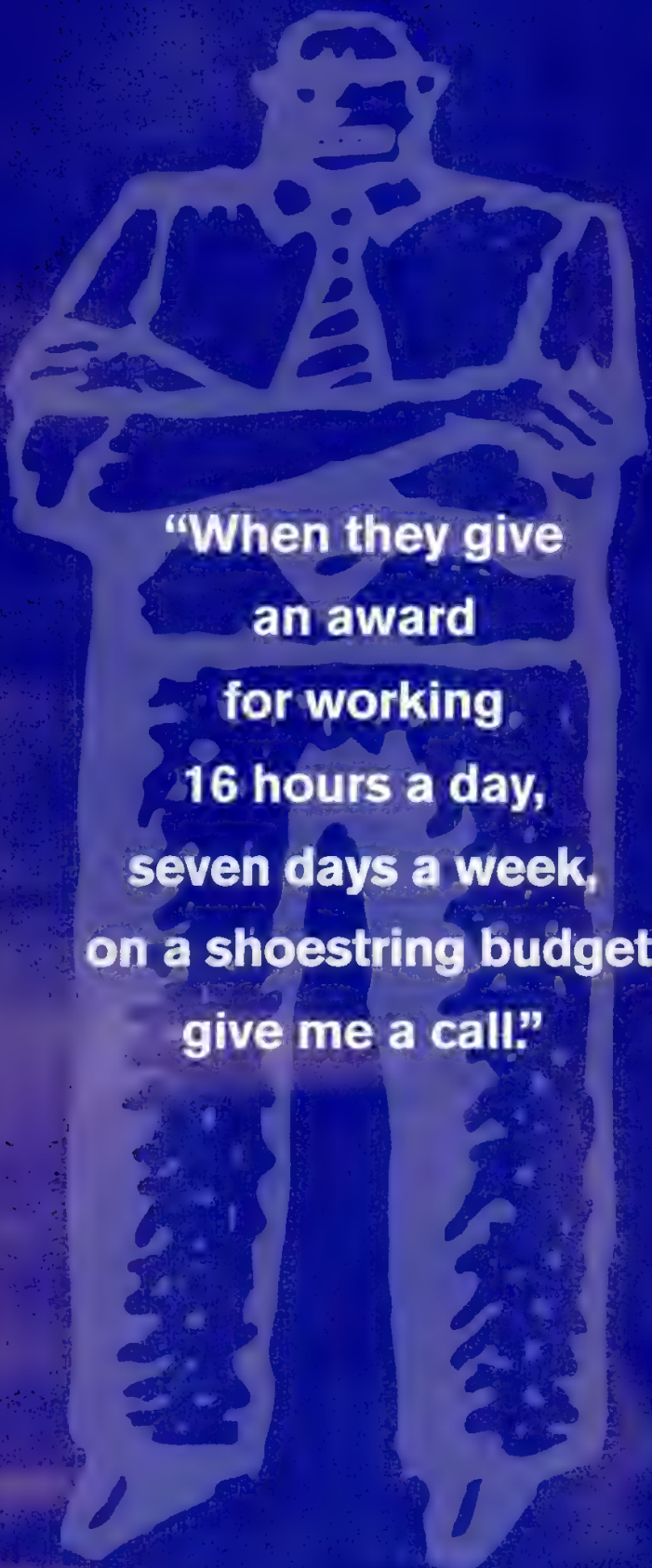
In the multifunction arena, Brother International Corp. takes the Editors' Choice with its Brother MFC-7150C (\$500). The unit offers good color ink jet output and color scanning/copying, excellent fax features, and decent speed at an attractive price. Honorable mention goes to the HP LaserJet 3100se (\$700), a 6-ppm laser that offers great monochrome printing, scanning, and excellent speed.

the cable pegboard and dropping another \$10 to \$25 on the way out of the store.

Also consider—with a grain of salt—a vendor's claimed speed and resolution ratings. Often, the speed the vendor cites is that in draft mode, not the speed at the printer's highest possible resolution. At the beginning of each review we put the vendors' claimed specs; look to our performance and output quality results to see how the units measure up under real-world use. Finally, we also present the grade each vendor received from our readers in our seventh annual Service and Reliability sur-

vey. Subscribers chosen at random were asked to rate the printers they've used in terms of satisfaction with reliability, repair, and technical support. We also asked them how many times in the past 12 months their printers have needed repair. Based on these four measures, we constructed a report card that assigns a grade to every major printer vendor (see our July 1998 issue for more on that study and its results).

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INK JETS

Canon BJC-50, BJC-80, BJC-250, BJC-4400, BJC-5000

BJC-50: 5.5-ppm monochrome/2-ppm color portable ink jet; 720 x 360 dpi; \$350 street. **BJC-80:** 4.5-ppm/2-ppm portable; 720 x 360; \$300. **BJC-250:** 4 ppm/0.5 ppm; 360 x 360; \$130 (\$100 after rebate). **BJC-4400:** 6.5 ppm/2.5 ppm; 720 x 360; \$180. **BJC-5000:** 7.5 ppm/3 ppm; 1,440 x 720; tabloid-size; \$250. Costa Mesa, CA; 800-652-2666; www.ccsi.canon.com; 521 at www.pcmag.com/infolink.

● Canon is pushing ink jet printer prices to new lows in its battle with HP and Epson for market share and delivers respectable products at very attractive prices here. Of the five models we tested, the BJC-50 (a portable aimed at road warriors), the BJC-4400 (suitable for a small or home office), and the business-oriented, tabloid-capable BJC-5000 are particularly good bets for their target markets.

All five models incorporate Canon's own Drop Modulation technology, an automatic resolution-enhancing technolo-

gy that lets the printhead place both full- and half-size dots on the same line; which helps produce superior photo-realistic images. Except for the BJC-5000, each also shares a similar software interface that lets users select full-color or fast-color modes, three types of halftoning, and several color adjustment options. In addition, the BJC-50, BJC-80, and BJC-4400 can double as 24-bit color sheet-fed scanners (360 by 360 dpi) by swapping the printhead for an optional \$99 Canon IS-12 or IS-22 Color Image Scanner Cartridge.

BJC-50, BJC-80: PORTABLE POWER

The BJC-50 is a lightweight printer capable of heavyweight output. Weighing 2 pounds and measuring 1.9 by 4.4 by 11.8 inches, it

includes a built-in lithium ion battery good for about 100 double-spaced pages of text per charge. Setup is easy, and you can print from your laptop via the included cable or the built-in IrDA port. Installing ink cartridges wasn't difficult, but the tiny reservoirs force you to replace the cartridges as often as every 11 pages, depending on the saturation of the output. The BJC-50 is one



The affordable Canon BJC-4400

of the few remaining three-color ink jets on the market, which means you'll have to swap cartridges between color and monochrome jobs, and composite black text in color documents will have a grayish appearance. To keep size and weight down, the BJC-50 requires you to feed paper manually, although a 30-page automatic sheet feeder is available (\$60).

In our labs, text quality using the black-ink cartridge was good; characters were crisp, clean, and consistent. Although the unit uses only a CMY cartridge, colors were accurate, pleasing, and bright without being overly saturated. Though we could see banding in our gradient test, it wasn't apparent in our photo image. We did notice some loss of detail in the highlights and shadows; the unit's photo output was judged *fair* by our jury. Despite some compromises, the small, silent BJC-50 is a good choice if you need a printer for the road.

One-third larger and a pound heavier than the BJC-50, the BJC-80 is more of a transportable than a portable printer. No battery is included, though an \$85 nickel hydride battery is available that's good for 200 pages per charge. The BJC-80's larger size and weight accommodate a built-in 30-page sheet feeder. Both the BJC-50 and BJC-80 use the same printhead and inks, so it's no surprise that image quality in our labs was comparable. We saw minor variations in aliasing, banding, and moirés, but

HOW WE RATED INK JET PRINTERS

	Price	Text quality	Photo quality	Overall speed	Vendor grade*
Canon BJC-50	\$350	Good	Fair	Fair	B
Canon BJC-80	\$300	Good	Fair	Fair	B
Canon BJC-250	\$130	Fair	Fair	Poor	B
Canon BJC-4400	\$180	Good	Good	Poor	B
Canon BJC-5000	\$250	Excellent	Good	Fair	B
Compaq LJ200	\$130	Fair	Fair	Poor	Not rated
Compaq LJ700	\$230	Excellent	Good	Good	Not rated
Compaq LJ900	\$300	Excellent	Good	Good	Not rated
❑ Epson Stylus Color 440	\$150	Good	Good	Good	A
Epson Stylus Color 640	\$200	Good	Good	Good	A
Epson Stylus Color 850	\$350	Excellent	Good	Excellent	A
Epson Stylus Color 1520	\$800	Excellent	Good	Excellent	A
HP DeskJet 340	\$300	Poor	Poor	Fair	A
HP DeskJet 697C	\$180	Good	Good	Good	A
HP DeskJet 712C	\$250	Excellent	Good	Excellent	A
HP DeskJet 722C	\$300	Excellent	Excellent	Excellent	A
❑ HP DeskJet 950Cee	\$400	Excellent	Excellent	Excellent	A
HP DeskJet 1120Cee	\$500	Good	Good	Good	A
HP DeskJet 2000Cee	\$800	Excellent	Excellent	Excellent	A
Lexmark 1100 Color Jetprinter	\$120	Fair	Fair	Fair	B
Lexmark 3200 Color Jetprinter	\$180	Excellent	Good	Good	B
Lexmark 5700 Color Jetprinter	\$250	Excellent	Good	Good	B
NEC SuperScript 650C	\$170	Fair	Fair	Good	B
Okidata OkidJet 2500	\$240	Fair	Fair	Fair	C
Xerox DocuPrint XJ6C	\$200	Fair	Fair	Fair	D
Xerox DocuPrint XJ6C	\$270	Good	Fair	Fair	D

* Service and Reliability survey, PC Magazine, July 1998.

❑ denotes Editors' Choice.

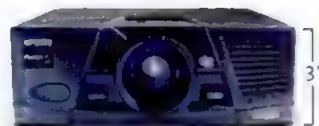
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PERFORMANCE TESTS

Ink Jet Printers



Traditionally, ink jet printers have been much slower than their laser counterparts. But that's starting to change, as some ink jets delivered laserlike throughput on our tests. And as our jury found, much of the output is stunning.

This roundup gave us a glimpse of the future of business and home ink jet printers. The top ink jets perform as well as low-end desktop laser printers, and they rival thermal dye printers in quality. In achieving this feat, Hewlett-Packard has taken the no-expenses-spared route in producing the HP DeskJet 2000Cse Professional Series, which was as quick as a color laser on some of our tests. At its \$800 street price, the 2000Cse is the most expensive ink jet we tested, but it's still one-third the price of a color laser printer. The price/performance standout, and one of our Editors' Choices, was the HP DeskJet 895Cse Professional Series, which delivered nearly as good speed and the same excellent output at half the price (\$400). Another sensible solution with a more modest price tag is the Epson Stylus Color 850 (\$350), which delivered just as good performance and almost as good quality as the DeskJet 2000Cse. The Epson printer achieves its performance thanks to an enhanced paper-feeding mechanism optimized for speed and a higher firing rate of ink droplets. Other overall price/performance standouts include the HP

► Ink jet printers are often used to print small jobs. The 1-page tests are a good measure of a printer's initial first-page-out delay, which dominates the elapsed time in printing small jobs. The HP DeskJet 2000Cse was by far the best, garnering 4.21 effective ppm in printing one page of pure text and 3.13 on text and graphics. The 12-page Microsoft Word Text test is a good indicator of the mechanical print engine speed. Reaching almost 6 effective ppm, the HP DeskJet 2000Cse stood out head and shoulders above every other entry in sheer print engine speed. The Epson Stylus Color 850 was a distant second. The 12-page Text and Graphics test reveals a printer's ability to handle graphics. Most of the ink jets took a significant performance hit when graphic elements were added to the print job. On the average, the ink jet printers slowed down by 44 percent.

JURY ANALYSIS OF PHOTO OUTPUT

High scores are best.

Bold type denotes first place.
E denotes Editors' Choice

	Overall rating	Dynamic range	Resolution	Color	Total points
ALPS MD-1300*	Excellent	Good	Excellent	Excellent	23.7
Canon BJC-50	Fair	Fair	Poor	Fair	10.1
Canon BJC-80	Fair	Fair	Poor	Poor	10.2
Canon BJC-250	Fair	Fair	Good	Fair	15.2
Canon BJC-4400	Good	Good	Good	Good	19.4
Canon BJC-5000	Good	Good	Good	Good	19.1
Compaq LJ200	Fair	Fair	Fair	Fair	13.7
Compaq LJ700	Good	Good	Good	Good	18.9
Compaq LJ900	Good	Good	Good	Good	20.5
Epson Stylus Color 440	Good	Good	Good	Fair	15.8
Epson Stylus Color 640	Good	Good	Good	Good	21.7
Epson Stylus Color 850	Good	Good	Good	Good	20.4
Epson Stylus Color 1520	Good	Good	Good	Good	18.3
HP DeskJet 340	Poor	Poor	Poor	Poor	9.4
HP DeskJet 697C	Good	Good	Fair	Good	18.6
HP DeskJet 712C	Good	Good	Good	Good	19.9
HP DeskJet 722C	Excellent	Excellent	Good	Good	22.6
HP DeskJet 895Cse	Excellent	Excellent	Good	Excellent	23.5
HP DeskJet 1120Cse	Good	Good	Good	Good	19.6
HP DeskJet 2000Cse	Excellent	Excellent	Excellent	Excellent	24.6
Lexmark 1100 Jetprinter	Fair	Good	Fair	Fair	15.4
Lexmark 3200 Jetprinter	Good	Good	Good	Good	18.4
Lexmark 5700 Jetprinter	Good	Good	Good	Good	20.1
NEC SuperScript 650C	Fair	Poor	Fair	Poor	10.3
Okidata OkJet 2500	Fair	Fair	Fair	Fair	16.3
Xerox DocuPrint XJ6C	Fair	Fair	Fair	Fair	14.9
Xerox DocuPrint XJ8C	Fair	Fair	Fair	Fair	15.5

* This thermal-dye printer is reported for comparison. See the sidebar "ALPS MD-1300: Personal Photo Studio."

▲ The jury found the HP DeskJet 2000Cse's output sample impeccable. The only printer to receive an Excellent rating in all three evaluation categories, the DeskJet 2000Cse automatically adjusts the

printing mode and resolution to those best suited for the print job at hand, yielding images that are arguably better than a thermal dye printer like the ALPS MD-1300, which we used for comparison.

INK JET PRINTERS

High scores are best. Bold type denotes first place.

Effective ppm
E denotes Editors' Choice

	Microsoft Word Text and Graphics 1 page color	12 pages color	Microsoft Word Text 1 page monochrome	12 pages monochrome	Microsoft Excel 2 pages color
Canon BJC-50	1.05	N/A	0.79	N/A	N/A
Canon BJC-80	1.07	1.18	2.10	2.44	0.70
Canon BJC-250	0.54	0.44	0.41	0.55	0.36
Canon BJC-4400	0.21	0.20	0.19	0.27	0.18
Canon BJC-5000	1.06	1.25	2.08	2.51	0.88
Compaq LJ200	0.51	0.44	0.42	0.54	0.38
Compaq LJ700	1.58	1.74	2.39	3.04	0.93
Compaq LJ900	1.53	1.75	2.47	3.03	0.90
Epson Stylus Color 440	0.89	1.04	1.86	2.87	0.74
Epson Stylus Color 640	1.65	1.71	1.68	2.23	1.35
Epson Stylus Color 850	2.37	3.67	3.42	4.64	1.86
Epson Stylus Color 1520	2.25	2.77	2.41	3.68	2.08
HP DeskJet 340	0.88	1.34	1.36	1.84	0.43
HP DeskJet 697C	0.72	0.68	2.24	2.30	0.48
HP DeskJet 712C	1.15	1.25	2.40	3.98	0.62
HP DeskJet 722C	1.10	1.26	2.32	3.95	0.19
HP DeskJet 895Cse	1.96	2.47	2.79	4.25	1.82
HP DeskJet 1120Cse	1.10	1.47	1.83	3.50	0.71
HP DeskJet 2000Cse	3.13	2.87	4.21	5.77	2.98
Lexmark 1100 Jetprinter	0.52	0.47	0.41	1.63	0.38
Lexmark 3200 Jetprinter	1.24	1.39	1.85	2.32	0.77
Lexmark 5700 Jetprinter	1.53	1.77	2.45	3.05	0.91
NEC SuperScript 650C	1.01	0.91	1.45	2.83	0.34
Okidata OkJet 2500	0.87	0.96	1.03	1.30	0.62
Xerox DocuPrint XJ6C	0.88	0.95	1.05	1.30	0.62
Xerox DocuPrint XJ8C	1.11	1.73	0.98	1.36	0.74
AVERAGE	1.22	1.41	1.79	2.54	0.83

BETTER ►

N/A—Not applicable: The Canon BJC-50 does not have a paper tray and thus could not perform our automated tests.

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Micron	81%
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Toshiba	61%
Compaq	58%
Packard Bell	51%
Windows Magazine, 8/97	

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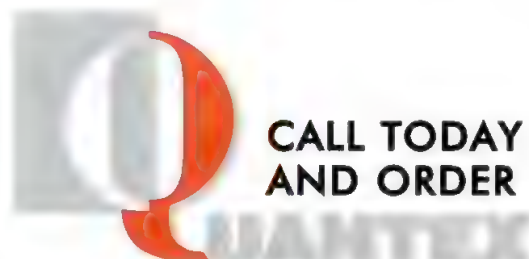
TECH SUPPORT EXPERIENCE

Vendor	Tech was knowledgeable	Tech tried everything to help	Prompt resolution	Got a run-around
Quantex	57%	59%	49%	9%
Micron	56%	47%	43%	9%
Gateway	54%	48%	45%	10%
Dell	54%	43%	49%	10%
IBM	41%	33%	36%	15%
Compaq	37%	30%	30%	17%
Average*	40%	33%	32%	16%

"Service and Reliability Survey," PC Magazine, July 1998
* calculations based on all 25 PC vendors evaluated in the survey

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- Integrated 16-bit Stereo Sound and Speakers
- Smart Lithium Ion Battery
- USB and Fast IR Ports
- Integrated Personal Touchpad
- MS Windows 98
- Corel Office Suite II
- Carrying Case
- 3-year limited warranty on CPU and Main Memory
- 1-year parts and labor limited warranty on all other components

T-1310 w/Pentium II processor 233MHz.....\$2199

OPTIONS: Mini-Docking Station \$149 • 2nd Lithium Ion Battery \$129 • PCMCIA NIC \$129 • Deluxe Carrying case \$99

Quantex T-1311 \$2499

Business lease: \$88/Mo.

- Pentium® II processor 266MHz
- Intel Mobile Module (I.M.M.) Architecture
- 13.3" XGA Active Matrix Display
- 64MB SDRAM/512KB Secondary Cache
- 4GB Ultra ATA HD / 3.5" 1.44MB Modular Floppy Drive
- 56K V.90 Fax/Modem*
- 24X Modular CD-ROM Drive
- 128-bit AGP Graphics Accelerator
- Integrated 16-bit Stereo Sound and Speakers
- Smart Lithium Ion Battery
- 2nd Lithium Ion Battery
- Mini-Docking Station
- USB and Fast IR Ports
- Integrated Personal Touchpad
- MS Windows 98
- Microsoft Office '97 SBE Ver 2
- Carrying Case
- 3-year limited warranty on CPU and Main Memory
- 1-year parts and labor limited warranty on all other components

T-1311 w/Pentium II processor 300MHz.....\$2749

Quantex T-1410 \$2899

Business lease: \$102/Mo.

- Pentium® II processor 300MHz
- Intel Mobile Module (I.M.M.) Architecture
- 14.1" XGA Active Matrix Display
- 64MB SDRAM
- 512KB Secondary Cache
- 6GB Ultra ATA HD / 3.5" 1.44MB Modular Floppy Drive
- 56K V.90 Fax/Modem*
- 2X DVD-ROM Drive
- 128-bit AGP Graphics Accelerator
- Integrated 16-bit Stereo Sound and Speakers
- Smart Lithium Ion Battery
- USB and Fast IR Ports
- Integrated Personal Touchpad
- MS Windows 98
- Microsoft Office '97 SBE Ver 2
- Carrying Case
- 3-year limited warranty on CPU and Main Memory
- 1-year parts and labor limited warranty on all other components

T-1410 w/Pentium II processor 300MHz.....\$3199

Quantex T-1411 \$3099

Business lease: \$104/Mo.

- Pentium® II Processor 300MHz
- Intel Mobile Module (I.M.M.) Architecture
- 14.1" XGA Active Matrix Display
- 64MB SDRAM
- 512KB Secondary Cache
- 6GB Ultra ATA HD / 3.5" 1.44MB Modular Floppy Drive
- 56K V.90 Fax/Modem*
- 2X DVD-ROM Drive
- 128-bit AGP Graphics Accelerator
- Integrated 16-bit Stereo Sound and Speakers
- Smart Lithium Ion Battery
- 2nd Lithium Ion Battery
- Mini-Docking Station
- USB and Fast IR Ports
- Integrated Personal Touchpad
- MS Windows 98
- Microsoft Office '97 SBE Ver 2
- Carrying Case
- 3-year limited warranty on CPU and Main Memory
- 1-year parts and labor limited warranty on all other components

Quantex I-1400 \$2399

Business lease: \$84/Mo.

- Pentium® II processor 300MHz
- Intel Mobile Module (I.M.M.) Architecture
- 14.1" XGA Active Matrix Display
- 64MB SDRAM
- 512KB Secondary Cache
- 4GB Ultra ATA HD / 3.5" 1.44MB Modular Floppy Drive
- 56K V.90 Fax/Modem*
- 24X Modular CD-ROM Drive
- ATI 3D AGP Graphics Accelerator w/8MB
- Integrated 16-bit Stereo Sound and Speakers
- Smart Lithium Ion Battery
- USB and Fast IR Ports
- Integrated Personal Touchpad
- MS Windows 98
- Corel Office Suite II
- Carrying Case
- 3-year limited warranty on CPU and Main Memory
- 1-year parts and labor limited warranty on all other components

I-1400 w/Pentium II processor 300MHz.....\$2599

Quantex I-1411 \$3399

Business lease: \$114/Mo.

- Pentium® II Processor 300MHz
- Intel Mobile Module (I.M.M.) Architecture
- 14.1" XGA Active Matrix Display
- 128MB SDRAM
- 512KB Secondary Cache
- 8GB Ultra ATA HD / 3.5" 1.44MB Modular Floppy Drive
- 56K V.90 Fax/Modem*
- 2X DVD-ROM Drive
- ATI 3D AGP Graphics Accelerator w/8MB
- Integrated 16-bit Stereo Sound and Speakers
- Smart Lithium Ion Battery
- 2nd Lithium Ion Battery
- Mini-Docking Station
- USB and Fast IR Ports
- Integrated Personal Touchpad
- MS Windows 98
- Microsoft Office '97 SBE Ver 2
- Carrying Case
- 3-year limited warranty on CPU and Main Memory
- 1-year parts and labor limited warranty on all other components

I-1411 w/Pentium II processor 266MHz.....\$3199



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VALUE MULTIMEDIA

QP6/333 M-1c \$1099

Business lease: \$39/Mo.

- Intel® Celeron® Processor 333MHz
- 64MB SDRAM Memory / 128KB Secondary Cache
- 4 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- 15" Digital Monitor (13.8" viewable)
- 64-Bit 3D PCI Graphics Accelerator with 4MB
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- 32X Max EIDE CD-ROM Drive
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-90 Speakers
- Quantex ATX Mid Tower Case
- 104-Key Keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3-year limited warranty with 1-year On-Site Service**

QP6/350 M-1x(with Pentium II processor).....\$1299

SOFTWARE: Corel Office Suite 8 • MS Money '97 • Compton's Interactive Encyclopedia • Body Works 6.0 • Amazon Trail II
American Heritage Talking Dictionary • Internet the City • Compton's Reference Collection • Dr. Solomon's Find Virus • MS Internet Explorer 4.0

QP6/350 M-2x \$1499

Business lease: \$53/Mo.

- Pentium® II Processor 350MHz/100MHz Front Side Bus
- 64MB SDRAM Memory / 512KB Secondary Cache
- 8 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- 17" Digital Monitor w/OSD (15.8" viewable)
- Toshiba MPACT2 3D Media Accelerator w/8MB VRAM
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- **New 3rd-Generation 4.8X DVD-ROM Drive**
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-90 Speakers
- Quantex ATX Mid Tower Case
- 104-Key Keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3-year limited warranty with 1-year On-Site Service**

QP6/333 M-2x(with Pentium II processor).....\$1399

QP6/400 M-3x \$1799

Business lease: \$63/Mo.

- Pentium® II Processor 400MHz/100MHz Front Side Bus
- 64MB PC100 SDRAM Memory / 512KB Secondary Cache
- 10 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- 17" Digital Monitor w/OSD (15.8" viewable)
- Upgrade to 17" Monitor w/NEC ChromaClear CRT for \$79
- Toshiba MPACT2 3D Media Accelerator w/8MB VRAM
- **Internal 100MB Zip Drive with one cartridge**
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- **New 3rd-Generation 4.8X DVD-ROM Drive**
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-90 Speakers
- Quantex ATX Mid Tower Case
- 104-Key Keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3-year limited warranty with 1-year On-Site Service**

QP6/350 M-3x(with Pentium II processor).....\$1599

QP6/450 M-4x \$2099

Business lease: \$74/Mo.

- Pentium® II Processor 450MHz/100MHz Front Side Bus
- 64MB PC100 SDRAM Memory/512KB Secondary Cache
- 10 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- **19" Monitor w/OSD (18.1" viewable), 1600x1200, 26dp**
- Intel®740 3D 2X AGP Graphics with 8MB SDRAM
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- **New 3rd-Generation 4.8X DVD-ROM Drive**
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-90 Speakers
- Quantex ATX Mid Tower Case
- 104-Key Keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3-year limited warranty with 1-year On-Site Service**
- Add Altec Lansing ACS-251 Subwoofer for \$39
- Upgrade to 15.0" LCD Flat-Panel Display for \$399

QP6/400 M-4x(with Pentium II processor).....\$1899

POWER MULTIMEDIA

QP6/450 SM-1x \$1199

Business lease: \$54/Mo.

- Pentium® II Processor 450MHz/100MHz Front Side Bus
- 64MB PC100 SDRAM Memory / 512KB Secondary Cache
- 6 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- 17" Digital Monitor w/OSD (15.8" viewable)
- Upgrade to 17" Monitor w/NEC ChromaClear CRT for \$79
- Intel®740 3D 2X AGP Graphics with 8MB SDRAM
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- 32X Max EIDE CD-ROM Drive
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-90 Speakers
- Quantex ATX Mid Tower Case
- 104-Key Keyboard with MS IntelliMouse
- MS Windows 98
- Power Multimedia Software Bundle
- Microsoft Office '97 SBE Ver 2
- 3-year limited warranty with 1-year On-Site Service**

QP6/400 SM-1x(with Pentium II processor).....\$1699

SOFTWARE: MS Office '97 Small Business Edition Ver 2 • MS Money '97 • Office Mate • Day Planner Pro • Power Business Plans • Form Designer Pro
• Project Manager Pro • Labels Unlimited • Compton's Reference Collection • Dr. Solomon's Find Virus • MS Internet Explorer 4.0

QP6/400 SM-2x \$1999

Business lease: \$70/Mo.

- Pentium® II Processor 400MHz/100MHz Front Side Bus
- 64MB PC100 SDRAM Memory / 512KB Secondary Cache
- 13 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- **17" Digital Monitor w/OSD & NEC ChromaClear CRT**
(16.0" viewable, 25 dp, 1600x1200 max resolution)
- **128-bit 3D 2X AGP Graphics w/16MB**
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- 32X Max EIDE CD-ROM Drive
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-45.1 Speakers with subwoofer
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98
- Power Multimedia Software Bundle
- Microsoft Office '97 SBE Ver 2
- 3-year limited warranty with 1-year On-Site Service**
- Upgrade to 15.0" LCD Flat-Panel Display for \$549

QP6/450 SM-2x(with Pentium II processor).....\$2199

QP6/400 SM-3x \$2199

Business lease: \$77/Mo.

- Pentium® II Processor 400MHz/100MHz Front Side Bus
- 128MB PC100 SDRAM Memory / 512KB Secondary Cache
- 13 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- **19" Monitor w/OSD (18.1" viewable), 1600x1200, 26dp**
- **#9 Revolution IV 128-bit 3D 2X AGP Graphics with 32MB**
- **Internal 100MB Zip Drive with one cartridge**
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- 32X Max EIDE CD-ROM Drive
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-45.1 Speakers with subwoofer
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98
- Power Multimedia Software Bundle
- Microsoft Office '97 SBE Ver 2
- 3-year limited warranty with 1-year On-Site Service**
- Upgrade to 15.0" LCD Flat-Panel Display for \$399

QP6/450 SM-3x(with Pentium II processor).....\$2399

QP6/450 SM-4x \$2499

Business lease: \$88/Mo.

- Pentium® II Processor 450MHz/100MHz Front Side Bus
- 128MB PC100 SDRAM Memory/512KB Secondary Cache
- **16 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive**
- **19" Monitor w/OSD (18.1" viewable), 1600x1200, 26dp**
- Intel®740 3D 2X AGP Graphics with 8MB SDRAM
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- **New 3rd-Generation 4.8X DVD-ROM Drive**
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- **New Altec-Lansing ADA-305 Dolby Surround Sound Speakers with subwoofer**
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98
- Power Multimedia Software Bundle
- Microsoft Office '97 SBE Ver 2
- 3-year limited warranty with 1-year On-Site Service**
- Upgrade to 15.0" LCD Flat-Panel Display for \$399

QP6/400 SM-4x(with Pentium II processor).....\$2299

SUPER MULTIMEDIA

QP6/450 M-4x SE \$2299

Business lease: \$81/Mo.

- Pentium® II Processor 450MHz/100MHz Front Side Bus
- 128MB PC100 SDRAM Memory / 512KB Secondary Cache
- 13 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- **19" Monitor w/OSD (18.1" viewable), 1600x1200, 26dp**
- Intel®740 3D 2X AGP Graphics with 8MB SDRAM
- **Internal 100MB Zip Drive with one cartridge**
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- **New 3rd-Generation 4.8X DVD-ROM Drive**
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-90 Speakers
- Quantex ATX Mid Tower Case
- 104-Key Keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3-year limited warranty with 1-year On-Site Service**
- Add Altec Lansing ACS-251 Subwoofer for \$39
- Upgrade to 15.0" LCD Flat-Panel Display for \$399

QP6/400 M-4x SE(with Pentium II processor).....\$2099

QP6/450 SM-4x SE \$2999

Business lease: \$105/Mo.

- Pentium® II Processor 450MHz/100MHz Front Side Bus
- 128MB PC100 SDRAM Memory / 512KB Secondary Cache
- **16.8GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive**
- **21" Monitor w/OSD (20.0" viewable), 1600x1200**
- **#9 Revolution IV 128-bit 3D 2X AGP Graphics with 32MB**
- **Internal 100MB Zip Drive with one cartridge**
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- 32X Max EIDE CD-ROM Drive
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ADA-305 Dolby Surround Sound Speakers & subwoofer
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS IntelliMouse
- MS Windows 98
- Power Multimedia Software Bundle
- Microsoft Office '97 SBE Ver 2
- 3-year limited warranty with 1-year On-Site Service**

QP6/400 SM-4x SE(with Pentium II processor).....\$2799

M-SERIES BEST BUY

QP6/450 Best Buy \$1999

Business lease: \$70/Mo.

- Pentium® II Processor 450MHz/100MHz Front Side Bus
- 64MB PC100 SDRAM Memory / 512KB Secondary Cache
- 8 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- **19" Monitor w/OSD (18.1" viewable), 1600x1200, 26dp**
- Intel®740 3D 2X AGP Graphics with 8MB SDRAM
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- **New 3rd-Generation 4.8X DVD-ROM Drive**
- SoundBlast® AudioPCI 64V Wavetable 3D Sound
- Altec-Lansing ACS-90 Speakers
- Quantex ATX Mid Tower Case
- 104-Key Keyboard with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- 3-year limited warranty with 1-year On-Site Service**
- Add Altec Lansing ACS-251 Subwoofer for \$39
- Add a Internal Zip Drive for \$79

GAMING BEST BUY

QP6/450 GX-2 \$2499

Business lease: \$88/Mo.

- Pentium® II Processor 450MHz/100MHz Front Side Bus
- 128MB PC100 SDRAM Memory / 512KB Secondary Cache
- 13 GB Ultra ATA HD / 3.5" 1.44MB Floppy Drive
- **19" Monitor w/OSD (18.1" viewable), 1600x1200, 26dp**
- Intel®740 3D 2X AGP Graphics with 8MB SDRAM
- **Internal 100MB Zip Drive with one cartridge**
- 56K V.90 PCI Fax/Modem* w/Voice Mail and Speakerphone
- **New 3rd-Generation 4.8X DVD-ROM Drive**
- Aureal® "ASD" 3D Positional PCI Sound
- **30fx Voodoo2 based 3D Game Accelerator w/12MB**
- MS SideWinder 3D Pro Joystick
- **New Altec-Lansing ADA-305 Dolby Surround Sound Speakers & subwoofer**
- Quantex ATX Mid Tower Case
- MS Natural Keyboard Elite with MS Mouse
- MS Windows 98
- Value Multimedia Software Bundle
- **Activation Game Titles: Battlzone, Heavy Gear**
Interstate 76 w/Nitro Pack
- 3-year limited warranty with 1-year On-Site Service**

QP6/400 GX-2(with Pentium II processor).....\$2299



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PERFORMANCE TESTS

DeskJet 712C and DeskJet 722C, aimed more at home users.

In general, the Canon printers were uninspiring in performance, but the portable Canon BJC-50 and BJC-80 surprised us with their print quality. Lexmark's family of ink jets, with the 5700 Color Jetprinter as the flagship, demonstrated solid but unspectacular performance and quality. The same can be said of the Compaq printers, which Lexmark makes for Compaq. The entries from NEC, Okidata, and Xerox were unimpressive in both quality and performance, especially considering the like-priced competition.

One caveat to keep in mind with these ink jets: Since they rely on the host PC to rasterize (process and render) the image, your CPU may bog down when you send a large, graphics-intensive color file. For example, return-to-application time when printing our six-page Microsoft PowerPoint file was sometimes a minute or more.—*Analysis written by S. Jae Yang*

How We Tested

For each printer, we asked the vendors to recommend the driver and resolution setting that typical users are expected to use, which in most cases was the default setting. With the exception of the Adobe Photoshop test, we did not adjust the driver settings according to different types of print jobs, because we felt the users of this class of printers will not be changing the settings for each type of printing application. We also used the same settings for both performance and quality tests. We measured the "click-to-clunk" time, which we defined as the interval from the moment you click the OK button in the print dialog box to the moment the last page is released to the output tray. Therefore, the test results here represent the performance that the users actually experience (not the rated engine speed cited by vendors). In the performance table, we present the data in "effective pages per minute," a calculation based on the click-to-clunk time, which includes the first-page-out delay at the beginning of each print job.

For measuring printer speed, we implemented PageSense II Printer Application Performance Test System (APTS), an automated test developed by Genoa Technology (www.genoalabs.com), a Moorpark, California-based company that specializes in developing automated tests for printers and fax machines. We installed all printers on a Pentium II/300-based NEC Direction with 64MB of RAM, operating on Windows 98 set to 1,024-by-768 resolution at true color. We set the parallel port to the enhanced capability port (ECP) mode and set the spooling mode to EMF unless the vendor specified otherwise. We disabled the printer's power management features if any.

PageSense II Printer APTS uses Visual Test as the programming platform for automating the application-based printer testing. The system uses an LED-based sensor device that detects the pages produced and released by the printer. PageSense II measures the return-to-application time and the time required for printing each page as detected by the sensor.

The **Microsoft Word Text and Graphics** test measures the printer's speed in using Word 97 to print a 1-page letter with a graphic letterhead and a 12-page document with heavily formatted text and graphics. The graphics consist of two half-page bitmapped images: one a photograph, the other an image with a large amount of black.

The **Microsoft Word Text** test measures the printer's speed in using Word 97 to print a 1-page text document consisting of monochrome text and a 12-page all-text document containing Arial, Times New Roman, and Courier TrueType 12-point fonts, unstyled.

For the **Microsoft Excel** test, we printed a two-page Excel 97 spreadsheet with tables and various types of graphs in color.

For the 1-page **Adobe Photoshop** test, we set the printer driver to

photo-quality paper mode and printed an 8-by-10, 300-dpi color image (in TIFF format) produced by the International Organization for Standardization (ISO).

For the **Microsoft PowerPoint** tests we printed six typical presentation slides from PowerPoint 97 on both plain paper and transparencies. The slides contained a demanding mix of text, graphics, and complex background patterns.

The one-page **Microsoft Publisher** newsletter document contains various typefaces and font sizes as well as photographic images.

To evaluate the ink jet printers' image quality, we conducted a **Jury Analysis** with a panel of 14 jurors randomly sampled from the *PC Magazine* staff. With each ink jet printer, we printed a 300-dpi 8-by-10 printer test file produced from ISO test images. The test sample was printed on photo-quality paper recommended or submitted by each printer's vendor. The jury evaluated each printer's output on the basis of three attributes: They assessed each printer's dynamic range by examining the contrast and the smoothness of tonal range in the sample. The jurors were asked to gauge the apparent resolution by scrutinizing the edges and details. They judged the authenticity and accuracy of color by the fineness of dither patterns, color registration errors, and overall believability of colors. To ensure fairness in the jury test, we concealed the identity of the output samples from the jurors and testers. We reprint a portion of the actual output sample used by the jury for each printer in this section.

▼ At 2.55 effective ppm, the DeskJet 2000Cse was the best on the Microsoft Excel test, followed by the Epson Stylus Color 1520 and Stylus Color 850. The DeskJet 2000Cse also outpaced the field on the Publisher Newsletter test. On the Adobe Photoshop test, the

DeskJet 2000Cse faded into the pack, leaving Epson Stylus Color 850 and Stylus Color 640 to lead the field. The DeskJet 2000Cse and the Stylus Color 850 were again the two best on both plain paper and transparencies on our PowerPoint test.

INK JET PRINTERS bold type denotes first place				
Effective ppm High scores are best	Microsoft Publisher 1 page color	Adobe Photoshop 1 page color	Microsoft Power- Point 6 pages color	Microsoft Power- Point Trans- parencies 6 pages color
 denotes Editors' Choice				
Canon BJC-50	0.11	0.08	N/A	N/A
Canon BJC-80	0.11	0.09	0.33	0.10
Canon BJC-250	0.27	0.12	0.26	0.13
Canon BJC-4400	0.13	0.10	0.11	0.11
Canon BJC-5000	0.56	0.27	0.25	0.25
Compaq IJ200	0.28	0.12	0.26	0.13
Compaq IJ700	0.43	0.18	0.40	0.15
Compaq IJ900	0.42	0.24	0.38	0.28
 Epson Stylus Color 440	0.46	0.14	0.51	0.16
Epson Stylus Color 640	0.80	0.53	0.78	0.77
Epson Stylus Color 850	1.34	0.56	1.40	1.34
Epson Stylus Color 1520	1.29	0.35	1.25	0.45
HP DeskJet 340	0.30	0.08	0.28	0.09
HP DeskJet 687C	0.37	0.10	0.28	0.27
HP DeskJet 712C	0.37	0.11	0.31	0.13
HP DeskJet 722C	0.14	0.12	0.31	0.20
 HP DeskJet 895Cse	0.38	0.13	0.90	0.42
HP DeskJet 1120Cse	0.43	0.30	0.46	0.22
HP DeskJet 2000Cse	1.79	0.38	1.62	1.83
Lexmark 1100 Jetprinter	1.05	0.41	0.26	0.26
Lexmark 3200 Jetprinter	0.37	0.18	0.34	0.19
Lexmark 5700 Jetprinter	0.43	0.27	0.39	0.28
NEC SuperScript 650C	0.77	0.18	0.26	0.24
Okidata Okijet 2500	0.52	0.32	0.35	0.20
Xerox DocuPrint XJ8C	0.52	0.32	0.35	0.20
Xerox DocuPrint XJ8C	0.38	0.24	0.33	0.28
AVERAGE	0.54	0.21	0.49	0.33

N/A—Not applicable. The Canon BJC-50 does not have a paper tray and thus could not perform our automated tests.

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Compare the Output *Ink Jet Printers*

Although ink jets now deliver better image quality, there's still wide variation among them. We chose a demanding photo image for our jury tests, printed on glossy paper at the manufacturers' re-

commended settings. Look for retention of detail in the highlight and shadow areas, no jaggedness on thin lines, sharp focus, and realistic color. The text sample is enlarged five times to show detail.



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear

◀ The ALPS MD-1300 is intended for photo-quality output for imaging professionals. We included its true continuous-tone thermal dye output in our jury evaluations, and it ranked *excellent*. (The text sample to the left is from a laser printer and is shown for comparison.) Our jury rated photo output from the HP DeskJet 722C, 895Cse, and 2000Cse as best, on a par with the ALPS MD-1300. The Epson Stylus Color 640 and 850 and the Lexmark Jetprinter 5700 topped the next tier with above-average output.



Dear



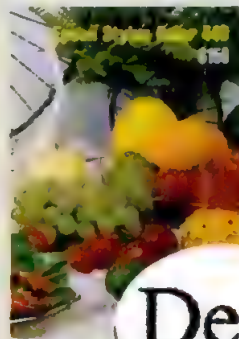
Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear



Dear

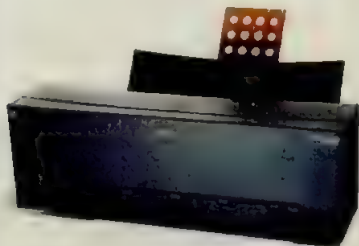


Dear

nothing significant. Colors were accurate and pleasing. Like its smaller brother, the BJC-80 generated good text with the dedicated black cartridge: black, sharp, and clean. We did see a difference in sharpness: For some reason, there's a very slight softness to the BJC-80's photo images. Like

ALPS MD-1300: Personal Photo Studio

The photographic output from the newest crop of ink jet printers is stunning indeed, but our jury found one thing better: the true continuous-tone output from the ALPS MD-1300 (\$500; ALPS Electric USA Inc., San Jose, CA; 800-825-2577; www.alpsusa.com; 532 at www.pcmag.com/infolink) we used for comparison. This (relatively) affordable thermal-dye unit doubles as a four-color dry toner (what ALPS



calls Micro Dry) unit. It can also print with ALPS' almost fluorescent metallic inks for special effects.

This specialized design pays off: The MD-1300 generates great photo-quality prints and decent graphics output, though at a snail's pace. The MD-1300 typically took about 16 minutes to make a full-page test print (a typical ink jet took closer to 10), but the prints were worth the wait. Images were crisp and colorful, banding was minimal, and despite the lack of a true black ink, the monochrome print looked as if it came from a photographic darkroom. Also, because the laminating process protects images against UV fading and fingerprints, photo output from the MD-1300 is much more stable and longer lasting than ink jet prints.—*DG and SWG*

the BJC-50, our jurors rated this unit's images as *fair*. On our speed tests, the BJC-80 was a respectable performer for text but sluggish with graphics-intensive files. Frankly, we liked the smaller, lighter BJC-50 more than the BJC-80.

BJC-250: NO-FRILLS BUDGET CHOICE

With a \$100 street price after rebate, Canon's BJC-250 is one of the least expensive name-brand color ink jets on the market. It's a slow, no-frills, three-color unit with limited features, but it's capable of producing fair to good text and graphics and decent photo images. It's a fine choice for a college student to pack for school, or as a second home printer.

Setting up the BJC-250 is easy. To cut costs, the printer has no receiver tray; paper simply cascades out onto your desktop (or floor). The BJC-250 comes with Canon Creative 3, a collection of useful and just-plain-fun fonts, projects, templates, and utilities, and Canon's WebRecord, an Internet printing utility that indexes a log of where you've surfed and formats the pages you specify for printing.

As for output quality, text was good from the black cartridge, but blacks were disappointing on pages that mixed text and color graphics (again, blame the three-color process). Photo printing also did not match that from the more expensive four-color printers but was on a par with the output of other low-priced units. There was also an unattractive chalky patina on photo-quality glossy paper, and we noticed that many of our test images printed slightly soft. Our jury tests rated this unit *fair* for photo output. The BJC-250 was also one of the slowest printers we tested. If price is your primary criterion for selecting a printer, the BJC-250 may fill the bill, but we suggest you spend a little more and trade up to a faster four-color model such as the BJC-4400.

BJC-4400: GREAT IMAGES, LOW PRICE

Moderate speed, good text, and fine image quality at an affordable price make the BJC-4400 a stand-out for SOHO users. This four-color printer uses a dedicated black cartridge and a separate color cartridge, the latter of which can be swapped out for Canon's six-color

photo-ink cartridge for photo printing.

Text on plain paper was of near-laser quality, with crisp, clean edges. Colors were rich and realistic, though skin tones were somewhat subdued. Our jurors rated this printer's images as *good*. The BJC-4400 is an excellent all-around printer that offers a winning combination of price, quality, and ease of use.

BJC-5000: TABLOID IMAGES

The BJC-5000 is half the price of the other tabloid-capable ink jets we tested (from HP and Epson), which puts it in a class by itself. Its clever dual-cartridge, twin-print-head design increases output speed by having each printhead traverse only half the page to generate full-page coverage. The BJC-5000 is a big printer, and although its paper handling is quite versatile, the feeder holds only 130 sheets. What's more, you must manually feed tabloid paper one sheet at a time.

During labs testing, we were impressed with the BJC-5000's bang-on color: vivid without exaggeration, as subtle as continuous tone, and realistic (especially on skin tones). Text looked as if it came from a high-resolution laser printer. The BJC-5000 was slower than the HP DeskJet 1120Cse (against which it competes) but was plenty fast for the price. Given its price, performance, range of media, and output quality, the BJC-5000 is tough to beat for oversize color images.—*Daniel Grotta and Sally Wiener Grotta*

Compaq IJ200, IJ700, IJ900

IJ200: 3.5 ppm/1.5 ppm; 600 x 600; \$130. **IJ700:** 5 ppm/2 ppm; 1,200 x 1,200; \$230. **IJ900:** 8 ppm/4 ppm; 1,200 x 1,200; \$300. Houston; 800-345-1518, 281-370-0670; www.compaq.com; 522 at www.pcmag.com/infolink.



The Lexmark-made Compaq IJ900.

For Windows®95, Windows®98, Windows NT®4.0



PHOTOSUITE II



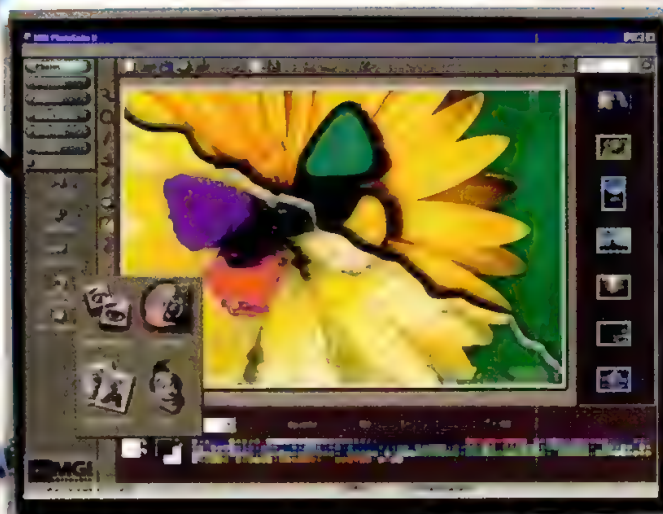
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Effortlessly capture, touch up, transform, organize, create, show, and share photos on your PC all within one application. NEW technology and enhanced features make MGI PhotoSuite II the most complete PC photography software. MGI PhotoSuite II delivers all the sophisticated, yet easy-to-use tools and functions necessary to achieve professional photo results. MGI PhotoSuite II – The Complete PC Photography Experience.



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- Search for photos by keyword in a photo album
- Create Web Albums
- Drag and drop photos from any web page



Projects



- Create photo collages
- Make photo cards and calendars
- Choose from a wide variety of home and business projects

Internet*



- Directly access the Web
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- Download **FREE** content, effects, features or user interface styles
- Direct link to Lycos Pictures and Sounds™ – over 40,000 FREE photos & sound clips

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- Create slide shows with photos, transitions, background music and sound effects

- Edit your photos
- Resize & rotate photos
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Photos

- Add special effects
- Warp photos

- Step-by-step Guides lead you through the process of working with photos on your PC
- Constant source of inspiration and direction

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COVER STORY

Ink Jet Printers

● These three Compaq printers are manufactured by Lexmark International and are closely comparable with the Lexmark Color Jetprinter models. (The cartridges for Compaq and Lexmark printers are not interchangeable, however.) Although Compaq's prices are higher than Lexmark's, retail bundle programs (such as a \$100 rebate when a customer purchases a computer, printer, and 15-inch monitor at the same time) can make the Compaq units attractive, especially with centralized support for all PC components. Still, none of these models stands out in its class.

The IJ200 is a low-cost printer suitable for students. This is a three-color model, and you'll need to swap between color and black cartridges. Worse, it comes standard with only a color cartridge, not the black cartridge you'll want for text output (\$32 list). There's no paper-out tray, and the 30-sheet paper-feed mechanism has a tendency to feed multiple pages at once. Bundled software includes Sierra Print Artist 3.0 Classic and Sierra Print Artist Craft Factory.

Text quality with the black cartridge is acceptable, though not a match for that of more expensive units. Text output from

the included color cartridge was less dense than we would like and rather fuzzy. Color output showed only minor banding but did not have the depth and sizzle of output from a four-color unit. Our jurors gave this printer's output a *fair* rating. The unit's speed was on a par with the rest of its class (which is to say, slow), though the Compaq IJ200 trailed the similar Lexmark 1100 Color Jetprinter on a few key tests.

Note that the IJ200's cost per page is a high 18.5 cents for a typical color page, so if you print a lot of color the money you save on the purchase price will quickly

SUMMARY OF FEATURES

Ink Jet Printers

■ YES ■ NO □ OPTIONAL

Products listed in review order

	Canon BJC-50	Canon BJC-80	Canon BJC-250	Canon BJC-4400	Canon BJC-5000	Compaq IJ200	Compaq IJ700	Compaq IJ900
Street price	\$350	\$300	\$130	\$180	\$250	\$130	\$230	\$300
Number of colors used in color/photo mode	3/3	3/3	4/4	4/7	4/7	3/3	4/8	4/8
Dimensions (HWD, in inches)	1.9 x 11.8 x 4.4	2.2 x 11.8 x 6.2	6.8 x 14.2 x 8.5	8.0 x 15.1 x 9.1	8.7 x 19.6 x 11.0	6.0 x 14.2 x 6.3	7.1 x 16.7 x 8.0	7.1 x 16.7 x 8.0
Weight (lbs.)	2.0	3.1	5.5	7.7	11.8	4.5	6.5	6.5
Rated engine speeds: draft mode (monochrome/color, in ppm)	Info not available	Info not available	Info not available	Info not available	Info not available	3.5/1.5	5/2	8/4
Rated engine speeds: best mode (monochrome/color, in ppm)	5.5/2	4.5/2	4/0.5	6.5/2.5	7.5/3	Info not available	Info not available	Info not available
Monochrome resolution in best mode	720 x 360	720 x 360	720 x 360	720 x 360	720 x 720	600 x 600	1,200 x 1,200	1,200 x 1,200
Color resolution in best mode	720 x 360	720 x 360	360 x 360	720 x 360	720 x 720	600 x 600	1,200 x 1,200	1,200 x 1,200
Parallel port/Serial port/USB port	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
IEEE 1284 cable	Included	Recommended	Recommended	Recommended	Recommended	Required	Required	Required
Prints from native DOS/Mac-compatible	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Driver for Windows NT / OS/2	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Price of internal network interface card	N/A	N/A	N/A	Third-party	N/A	N/A	N/A	N/A
Input/output tray capacity (sheets)	1 / N/A	1 / N/A	100 / 100	100 / 100	130 / 130	30 / N/A	100 / 25	100 / 25
Envelope input capacity/Heaviest paper (lbs.)	5 / 30	5 / 38	15 / 28	15 / 30	15 / 146	1 / 124	10 / 120	10 / 120
Prints on card stock/transparencies	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Prints on T-shirt transfers	■	■	■	■	■	■	■	■
Prints on labels	■	■	■	■	■	■	■	■
Prints on tabloid-size paper (11" x 17")	■	■	■	■	■	■	■	■
Banner printing (maximum length, in inches)	N/A	N/A	86	66	66	110	N/A	N/A
Watermark/booklet printing	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Cost of high-capacity black ink cartridge	\$40.00	\$40.00	\$30.00	\$35.00	\$35.00	\$31.99	\$32.99	\$32.99
Cost per color cartridge	\$45.00	\$45.00	\$37.00	\$50.00	\$50.00	\$36.99	\$39.99	\$39.99
Separate cartridge for each color	■	■	■	■	■	■	■	■
Stops printing if one color runs out	■	■	■	■	■	■	■	■
Rated cost per page, 5% black coverage	6 cents	5 cents	8 cents	4 cents	4 cents	5.3 cents	5.5 cents	5.5 cents
Rated cost per page, 15% color coverage	17 cents	17 cents	13 cents	16 cents	16 cents	18.5 cents	10.8 cents	10.8 cents
Application software included	None	Canon Creative, WebRecord	Canon Creative, WebRecord	Canon Creative, WebRecord	Canon Creative, WebRecord	CorelDraw 7.0, Corel Dream 3D 7, Corel PhotoPaint 7.0, LivePix Deluxe 2.0, Sierra Print Artist Classic 3.0	LivePix Deluxe 2.0, Sierra Print Artist Classic 3.0, Sierra Print Artist Craft Factory	Sierra Print Artist Classic 3.0, Sierra Print Artist Craft Factory
Live technical support (eastern time)	24 hours, 7 days	24 hours, 7 days	24 hours, 7 days	24 hours, 7 days	24 hours, 7 days	24 hours, 7 days	24 hours, 7 days	24 hours, 7 days
Warranty	1 year	1 year	1 year	1 year	1 year	1 year	1 year	1 year
Overnight exchange under warranty	■	■	■	■	■	■	■	■

N/A-Not applicable: The product does not have this feature.

evaporate. So although the IJ200 is good enough for home users or students who do only minimal printing, we recommend you trade up to an inexpensive four-color model such as the Canon BJC-4400 (\$180) or Epson Stylus Color 440 (\$150).

The midrange IJ700 is a four-color model that delivers a good balance of features, price, and performance for home users and small businesses. The 100-sheet paper tray worked without jamming or double feeding, and the unit's cost per color page is more in line with that of other ink jets (11 cents). Text was of near-laser quality, with well-formed characters

and crisp edges. Color print samples exhibited noticeable banding on plain paper. Moving up to photo paper yielded pleasing, smooth images with very good colors. Our jurors gave the IJ700's image quality a rating of *good*. In speed testing, the unit proved to be a relatively quick mover, especially for text documents. The IJ700 is a reasonable—though not thrilling—choice for home-office or business users.

The IJ900 uses the same ink cartridges as the IJ700 and has many of the same functional specifications, but it incorporates a heavy-duty and reliable 100-sheet

paper-feed mechanism. Text and graphics output was very similar to that of the IJ700. Our speed tests showed the IJ900 to be slightly faster than the IJ700 for color prints and equal to it for text. The unit's software bundle includes CorelDraw 7.0, CorelDraw 3D 7, Corel PhotoPaint 7.0, LivePix Deluxe 2.0, and Sierra Print Artist Classic 3.0. Still, at this price we got better speed and output quality from the HP 722C.

If you're buying a Compaq printer as part of a system purchase, you won't be disappointed. But if you want best-in-class, shop around.—Bruce Brown

See www.pcmag.com for interactive views

Continues

PC MAGAZINE
EDITORS' CHOICE

PC MAGAZINE
EDITORS' CHOICE

Epson Stylus Color 440	Epson Stylus Color 640	Epson Stylus Color 850	Epson Stylus Color 1520	HP DeskJet 340	HP DeskJet 697C	HP DeskJet 712C	HP DeskJet 722C	HP DeskJet 895Cse Professional Series	HP DeskJet 1120Cse
\$150	\$200	\$350	\$800	\$300	\$180	\$250	\$300	\$400	\$500
4/4	4/4	4/4	4/4	4/4	4/6	4/4	4/4	4/4	4/4
6.1 x 16.9 x 9.1	6.1 x 16.9 x 9.1	7.0 x 18.7 x 10.8	8.0 x 26.0 x 20.0	5.9 x 12.2 x 2.8	17.2 x 7.9 x 18.0	17.5 x 7.3 x 14.0	17.5 x 7.3 x 14.0	17.5 x 7.2 x 13.8	8.8 x 22.8 x 15.0
11.5	11.5	14.3	25.5	4.3	11.6	12.0	12.0	12.0	20.7
4/2.5	5/3.5	9/5.5	8/5	3/0.25	5/1.7	8/3	8/4	10/3	8.5/4.5
Info not available	Info not available	Info not available	Info not available	2/0.5	1/0.3	4/0.2	4/0.5	4.5/0.3	4/0.2
720 x 720	1,440 x 720	1,440 x 720	1,440 x 720	600 x 300	600 x 600	600 x 600	600 x 600	600 x 600	600 x 600
720 x 720	1,440 x 720	1,440 x 720	1,440 x 720	300 x 300	600 x 600	600 x 600	600 x 600	600 x 600	600 x 600
■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Required	Required	Required	Required	Required	Required	Required	Required	Required	Required
■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
N/A	N/A	\$329	\$329	N/A	N/A	N/A	N/A	N/A	N/A
100/30	100/30	100/30	100/30	36/N/A	100/50	100/50	100/50	100/50	150/50
10/24	10/24	10/24	10/24	N/A/24	20/110	15/110	15/110	15/110	15/36
■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
■	■	■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■	■	■
44	44	44	44	N/A	54	54	54	54	54
■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
\$21.21	\$21.21	\$28.99	\$28.99	\$26.11	\$35.99	\$35.99	\$35.99	\$35.99	\$28.73
\$25.46	\$25.46	\$26.99	\$26.99	\$26.83	\$36.99	\$39.99	\$39.99	\$39.99	\$30.39
■	■	■	■	■	■	■	■	■	■
6 cents	6 cents	3.2 cents	2.8 cents	4 cents	4 cents	3 cents	3 cents	3 cents	3 cents
9 cents	9 cents	8.8 cents	8.4 cents	23 cents	12 cents	9 cents	9 cents	9 cents	9 cents
Adobe PhotoDeluxe 2.0, CreateCard and Sticker-PIX Lite, Disney's Daily Blast (6 months free)	Adobe PhotoDeluxe 2.0, CreateCard SE, The Print Shop Premiere Edition, DogByte Business Cards	The Print Shop PressWriter, Kai's PhotoSoap SE	None	None	HP Printing Possibilities Project Guide	HP Printing Possibilities Project Guide	HP Creative Solutions Project Kit, HP Extra!	HP Printing Essentials Kit	Corel Print and Photo House Select 2.0; iPublish 2.0 trial version
Noon-midnight M-F	Noon-midnight M-F	Noon-midnight M-F	Noon-midnight M-F	Noon-midnight M-F	8:00 A.M.-midnight M-F, 11:00-11:00 Sat.	8:00 A.M.-midnight M-F, 11:00-11:00 Sat.	8:00 A.M.-midnight M-F, 11:00-11:00 Sat.	8:00 A.M.-midnight M-F, 11:00-11:00 Sat.	8:00 A.M.-midnight M-F, 11:00-11:00 Sat.
1 year	1 year	1 year	2 years	1 year	1 year	1 year	1 year	1 year	1 year
■	■	■	■	■	□	□	□	□	■

COVER STORY

Ink Jet Printers

Epson Stylus Color 440, 640, 850, 1520

440: 4 ppm/2.5 ppm; 720 x 720; \$150. 640: 5 ppm/3.5 ppm; 1,440 x 720; \$200. 850: 9 ppm/5.5 ppm; 1,440 x 720; \$350. 1520: 6 ppm/5 ppm; 1,440 x 720; C-size (17- x 22-inch); \$800. Torrance, CA; 800-463-7766, 310-782-0770; www.epson.com; 523 at www.pcmag.com/infolink.



Prices are down and print speeds are up in Epson's extensive ink jet line, and each printer we tested is a contender in its market niche. The affordable Stylus Color 440, fast Stylus 850, and oversize Stylus 1520 are particularly worthy of note.

All four models use Epson's Micro Piezo printhead technology, which relies on an electro-mechanical process to produce droplets, instead of the boiling used by most competing designs. This makes it possible to use ink formulas that have better color, better paper penetration, and more rapid drying characteristics; we awarded Epson's Micro Piezo an Award for Technical Excellence in 1997. These models also offer among the lowest costs per page for color output.

FOR THE HOME

Unlike its competitors, Epson doesn't offer a bargain-basement three-color ink jet in the United States, starting its line

instead with the four-color Stylus Color 440. This home-user-oriented printer delivers good images and moderate speed for a low price, and is our Editors' Choice for home users. Setup was a snap, and the 440's print driver supports handy features such as multiple thumbnails per page and watermarks. The family-friendly bundle includes Adobe PhotoDeluxe, Micrografx's American Greetings CreatoCard, and StickerPIX Lite.

On our tests, plain-paper text output was good for an entry-level unit, with dense, well-formed characters. Color samples showed only faint banding and signs of dithering but excellent color and dynamic range. Our jurors rated this

SUMMARY OF FEATURES

Ink Jet Printers

Ends

	HP DeskJet 2000Cse Professional Series	Lexmark 1100 Color Jetprinter	Lexmark 3200 Color Jetprinter	Lexmark 5700 Color Jetprinter	NEC SuperScript 650C	Okidata OkiJet 2500	Xerox DocuPrint XJ6C	Xerox DocuPrint XJ8C
Street price	\$800	\$120	\$180	\$250	\$170	\$200	\$150	\$270
Number of colors used in color/photo mode	4/4	3/3	4/6	4/6	5/5	4/4	4/4	4/6
Dimensions (HWD, in inches)	16.9 x 19.7 x 7.9	14.2 x 6.3 x 6.0	8.2 x 18.3 x 11.0	6.0 x 17.0 x 8.0	14.8 x 7.9 x 14.2	7.6 x 16.4 x 11.8	16.3 x 11.3 x 7.6	17.0 x 8.0 x 6.0
Weight (lbs.)	21.5	4.5	7.8	8.5	10.4	10.1	11.2	9.0
Rated engine speeds: draft mode (monochrome/color, in ppm)	10/7	3.5/1.5	6/2.5	8/4	6/2	5/2.5	Info not available	Info not available
Rated engine speeds: best mode (monochrome/color, in ppm)	6.5/1.5	3.5/1.5	6/2.5	8/4	Info not available	Info not available	5/2.5	8/4
Monochrome resolution in best mode	600 x 600	600 x 600	1,200 x 1,200	1,200 x 1,200	1,200 x 600	1,200 x 600	300 x 300	300 x 300
Color resolution in best mode	600 x 600	600 x 600	1,200 x 1,200	1,200 x 1,200	1,200 x 600	1,200 x 600	300 x 300	300 x 300
Parallel port/Serial port/USB port	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
IEEE 1284 cable	Required	Required	Required	Required	Required	Required	Required	Required
Prints from native DOS/Mac-compatible	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Driver for Windows NT / OS/2	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Price of internal network interface card	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Input/output tray capacity (sheets)	150 / 75	30 / 10	100 / 25	100 / 25	120 / 60	150 / 50	125 / 50	100 / 25
Envelope input capacity/Heaviest paper (lbs.)	20 / 42	N/A / 24	N/A / 24	Manual feed / 24	25 / 24	10 / 110	1 / 32	1 / 32
Prints on card stock/transparencies	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Price of T-shirt transfers	■	■	■	■	■	■	■	■
Prints on labels	■	■	■	■	■	■	■	■
Prints on tabloid-size paper (11" x 17")	■	■	■	■	■	■	■	■
Banner printing (maximum length, in inches)	N/A	110	110	110	N/A	55	55	Info not available
Watermark/booklet printing	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Cost of high-capacity black ink cartridge	\$29.99	N/A	\$41.99	\$32.95	\$21.95	\$10.99	\$9.99	\$39.99
Cost per color cartridge	\$29.99	\$41.99	\$41.99	\$38.95	\$44.95	\$11.99	\$9.99	\$34.99
Separate cartridge for each color	■	■	■	■	■	■	■	■
Stops printing if one color runs out	■	■	■	■	■	■	■	■
Rated cost per page, 5% black coverage	2.5 cents	Info not available	Info not available	Info not available	3.3 cents	4 cents	3.9 cents	3.7 cents
Rated cost per page, 15% color coverage	5.2 cents	Info not available	Info not available	Info not available	22 cents	12.3 cents	8 cents	14.6 cents
Application software included	Office in Color business templates	Windows Draw 6 SE	CreatoCard SE, Windows Draw 6 SE	Lexmark CD-ROM Workshop for Photos	NEC Color Value Pack	The Print Shop	PhotoBase, PhotoFantasy, PhotoPrinter, PhotoStudio	PhotoBase, PhotoFantasy, PhotoPrinter, PhotoStudio
Live technical support (eastern time)	8:00 A.M. - midnight M-F, 11:00-11:00 Sat.	9:00-9:00 M-F, noon-6:00 Sat., Sun.	9:00-9:00 M-F, noon-6:00 Sat., Sun.	9:00-9:00 M-F, noon-6:00 Sat., Sun.	8:30-8:00 M-F	24 hours, 7 days	8:00-5:00 M-F, 9:00-noon Sat.	8:00-5:00 M-F, 9:00-noon Sat.
Warranty	1 year	1 year	1 year	1 year	1 year	2 years	3 years	3 years
Overnight exchange under warranty	■	■	■	■	■	■	■	■

N/A-Not applicable; The product does not have this feature.

At These Prices, How Can You Not Make A Smart Move?



Compaq Presario 1622 Notebook

- Pentium® processor with MMX™ technology 233 MHz
- 12.1" High-Contrast STN Display
- 32 MB SyncDRAM
- 3.2 GB* Hard Drive
- 20X* CD-ROM Drive
- 56K Modem*
- Microsoft® Windows® 95

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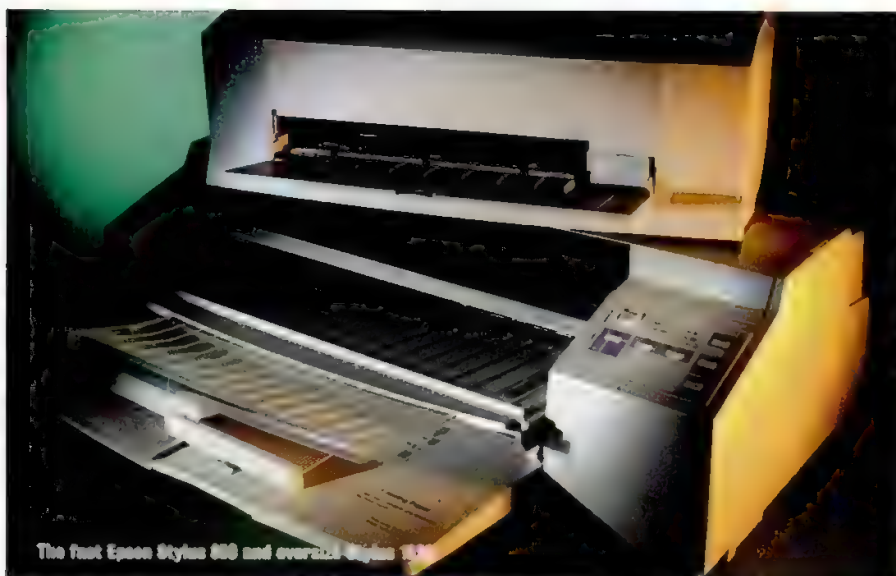
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PCM110398



HP DeskJet 340, 697C, 712C, 722C, 895Cse, 1120Cse, 2000Cse

340: 3 ppm/0.25 ppm portable; 300 x 300; \$300. **697C:** 5 ppm/1.7 ppm; 600 x 300; \$180. **712C:** 6 ppm/1 ppm; 300 x 300; \$250. **722C:** 8 ppm/1.5 ppm; 300 x 300; \$300. **895Cse:** 10 ppm/3 ppm; 300 x 300; \$400. **1120Cse:** 6.5 ppm/4.5 ppm; 300 x 300; tabloid-size; \$500. **2000Cse:** 10 ppm/7 ppm; 300 x 300; \$800. Palo Alto, CA; 800-752-0900; www.hp.com; 524 at www.pcmag.com/infolink.



Hewlett-Packard's ink jet printers run the gamut from a small, portable notebook companion to a heavy-duty tabloid workhorse. Although each model reviewed here is targeted at a separate segment within the home, SOHO, or mainstream business markets, all but the now-dated DeskJet 340 share a winning combination of above-average image quality, fast print speeds, and a sensible software bundle.

One of the first things we noticed in this year's batch of HP ink jets is that output quality tended to be remarkably similar from one unit to the next. In every case but one (the three-year-old DeskJet 340), text was dark, well formed, and easily readable—of true laser quality. Graphics in virtually every case offered solid thin lines, crisp edges (even with colored text on a colored background), and reasonably brilliant colors on plain paper. Dithering effects were limited, showing only as graininess.

Even photo output was remarkably consistent—and remarkably good. In each case it was close to true photographic quality, with no visible dithering, appropriately subtle shading, and good details across the entire range from light to dark.

With the exception of the 340 and 697C units (which use a separate ink technology), HP manages to produce this consistently good output by using a unique combination of two techniques that improve image quality beyond what 300-dpi resolution can itself produce. The first is *edge enhancement*, which smooths edges in text and graphics by adding smaller-than-usual dots on edges and lines to eliminate raggedness. This technique makes output look as sharp as you would expect from a 600-dpi printer.

The second technique is *multilevel* printing, a color-layering technology that

printer's output as *good*. On our speed tests, the 440 was much faster than other entry-level ink jets, and scores on the whole were acceptable. Price-sensitive buyers should pass on the \$100 three-color units and end their searches here.

The Stylus 640, aimed more at the SOHO buyer, is identical in exterior design to the 440. The print engine is capable of higher maximum resolution (1,440 by 720 dpi), which means noticeably better color output. Text on plain paper was of near-laser quality. Color on plain paper showed vibrant color with only faint signs of banding. Photo samples were terrific. On our speed tests, the 640 was noticeably faster than the 440 and was one of the faster ink jets in its price range. In general, the 640 is a sensible buy for SOHO users who need quick, clean text and some photo capabilities.

FOR THE OFFICE

If your major concern is speed, the Stylus Color 850 is excellent. Designed for individual and even small-workgroup use, this printer posted some of the highest-speed results in this roundup and rivaled some of the slower laser printers. We tested the base model; Epson also offers the 850N (\$550), a network-ready version with a built-in 10Base-T/10Base2 print server.

In our labs, text on plain paper was nearly indistinguishable from output from a 600-dpi laser printer. Most color images showed even coverage, smooth gradients, and excellent skin tones. The 850's photo output rated well with our

jury, though it was edged out by the HP DeskJet 895Cse. Still, this is a great choice for anyone who wants fast prints of graphics, photos, and text—without spending too much money.

Business and graphics professionals who need oversize output for posters, brochures, and even CAD/CAE output should turn to the Stylus Color 1520, which can handle page sizes up to 17 by 22 inches (C-size). Most printers with this capacity are intended for professional graphics artists, but the 1520 is designed to be easy to use and versatile for general business applications as well. In addition to an adjustable input paper tray, the printer comes standard with adjustable pin-feed tractors, and it can accept rolls of paper for printing banners using an optional adapter (\$42 list). The 1520 uses the ESC/P2 printer language. However, because some users may want to use it for CAD or other specialized design applications, it also supports the HPGL/2 plotter language and comes with an AutoCAD ADI driver. For publishing pros, Epson offers an Adobe PostScript Level 2 upgrade (\$99).

On our speed tests, the 1520 was a standout, outpacing most competitors. Here again, text was of true laser quality, with razor-sharp edges. Color output showed smooth ink coverage, excellent facial shades, and crisp edges with just a hint of banding. Our jury rated its photo output *good*. The 1520 is an excellent choice if you need extra paper handling capabilities combined with Epson's high level of performance.—*Alfred Poor*

DLP VS. LCD: A DIGITAL DIFFERENCE YOU CAN SEE AND FEEL.

By S. E. Easter

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makes dithering in graphics and photos harder to see or even invisible to the naked eye. Most printers print each dot of color in one of only two intensities (*on* or *off*), using cyan, magenta, yellow, or black ink. They can mix inks to create red, green, and blue and can create the illusion of other colors by distributing dots of different colors on the page. Multilevel printing expands this process by permitting more possible intensities for each printed dot, letting the printer use fewer dots to create dithered colors and making the patterns harder to see.

One more thing to note: Except in the case of the DeskJet 340, HP tends to be vague about resolution. In some cases, the manual lists the resolution not as a number, but as HP PhotoREt II. In others, it claims 600- by 600-dpi resolution, but then says in a footnote this is actually 300-dpi resolution with multilevel printing and resolution enhancement. Blame it on marketing, as HP no doubt felt the pressure to keep up with Epson in the resolution race. For the record, the 712C, 722C, 895Cse, 1120Cse, and 2000Cse are all 300-dpi printers, and they all take advantage of the enhancements discussed above. Also for the record: Our jurors judged these printers to have the best photo output in the roundup.

Setup for all the printers is standard fare—just install the software, plug in the power and data cables, then snap in and align the ink cartridges. The drivers are all variations on the same theme: In addition to standard Windows settings, you'll find paper options that include plain paper and specific HP paper types. You'll also find settings for gray scales, a choice of quality modes, and HP's fully automatic mode, called ColorSmart.

ColorSmart is automatically turned on by default. Though specific details vary with the printer, in all cases ColorSmart lets the driver determine the contents of the print job—text, vector graphic, or bitmap (including photos)—and lets it set color calibration and dithering as appropriate. The driver also uses the type of print job to determine the resolution of each print quality mode. In our labs we found that the automatic mode on each printer consistently picked the best settings.

340: LACKLUSTER PORTABLE

The portable, battery-operated HP DeskJet 340 has been available since 1995 and shows its age in its poor output quality for graphics and photos. A somewhat sluggish performer, it's also significantly heavier (5.4 pounds) and larger (12 by 4

by 6 inches) than the 2-pound Canon BJC-50 portable, though this weight includes a detachable 30-sheet feeder.

In our labs, printouts were acceptable for text, with some fuzziness (reminiscent of the ink jets of yore) and noticeable grayness with the color cartridge installed.

Consumables: The Hidden Cost

The biggest trend of all in the ink jet printer market may not be the printers at all: The focus is turning to the supplies side of the market, as both home and business users realize that all that dazzling color comes at a price.

Today's printer vendors are following much the same model the razor blade business does: Trim margins on the hardware up front to keep them coming back for consumables. The manufacturers typically have much higher

gross margins on consumables (ink and paper) than on the printers themselves. For example, Hewlett Packard has a gross margin of 67 percent on ink jet supplies—twice the 33 percent margin for the overall company, according to a *Business Week* article last year.

And while ink jet supplies accounted for just 5 percent of company revenues, sales of these consumables produced a whopping 25 percent of total profits.

Anyone who has turned the kids loose on a rainy Saturday, only to quickly deplete a \$35.99 ink cartridge for a few pieces of refrigerator art, knows that the 15- to 20-cent cost of a typical color page adds up quickly. And at up to 4 cents per page, simple text documents are twice the cost of laser-printed output. There are alternatives to the branded inks and papers, and third-party suppliers are hungry to carve out a piece of the

profit pie. Some offer refilled or remanufactured cartridges at considerable savings. Manufacturer cartridges for an Epson Stylus Color 800 sell for about \$28 for black and \$28 for color, but third-party cartridges are available for as little as \$12 for color and \$7.50 for black. If you're willing to risk dyeing your fingers, you can buy a \$50 kit that will refill HP DeskJet 600 cartridges (five times for black, eight times for each of the three colors).

But the printer vendors are quick to point out that they do not sanction such substitutions. They note that their print-heads, ink formulations, and paper are designed to work together to produce the best output and to result in the longest possible life of the print-head. Remanufac-

COST COMPARISON

It is significantly cheaper to opt for off-brand ink in ink jet consumables. But do you get what you pay for?

	Epson products	Third-party products
Black cartridge	\$29.00	\$7.50
Cost per page, 5% text*	3.2 cents	< 1 cent
Color cartridge	\$27.00	\$12.00
Cost per page, 15% color*	8.8 cents	4 cents

* Estimates are based on advertised prices and vendors' claimed figures for coverage.

tured ink cartridges can rupture, and the wrong ink chemistry can cause clogs. Worse, if a problem with your printer is traced to a third-party cartridge, the printer maker has the option of voiding the warranty, which could leave you with an expensive repair bill.

Still, the third-party vendors are finding a market, and the original manufacturers are already feeling the pressure to lower costs. As a result, you may well see a pricing battle waged in the coming year—and the ultimate winners should be the consumers.—AP

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COVER STORY

Ink Jet Printers

Graphics and photos were disappointing, showing obvious dithering, broken thin lines, somewhat dull colors, and a medium gray for what should have been solid black. Photos showed obvious dithering in the form of graininess and mottled colors, along with a lack of crispness with edges. Oddly, the special paper the 340 requires for glossy photos had an unpleasant, almost sticky feel. On our jury tests for image quality, the 340 was the only printer in the roundup rated *poor* overall. Speed wasn't a strong point either. If you need a companion printer on the road, look to the Canon.

HOMEODIES

The HP DeskJet 697C and DeskJet 712C are meant to be all-purpose printers for home users and students. Both offer a full range of capabilities, from reasonable speed and good text quality to photo printing. But while the 712C offers somewhat better color graphics and a much faster rated speed—particularly for its best mode—the 697C offers six-color printing for better photo prints.

The 697C, a true 600-dpi printer, takes a different approach to obtain essentially the same level of quality as the rest of the HP ink jets. Though it functions as a standard four-color printer for text and graphics, the special cartridge design lets you turn it into a six-color printer for better photo prints. Just swap out the black ink cartridge and exchange it for a special three-color cartridge. As with dedicated photo-centric ink jets that use six colors, the two additional inks let the printer create a wider range of colors and subtler shading. We found the 697C to be excellent with shading and fine gradations in tone, but somewhat less proficient at reproducing crisp edges. Tested print speeds were about average for an ink jet.

The bundled software consists of PrintMaster Gold Publishing Suite (a program that lets you create banners, calendars, greeting cards, and more) and two image-editing programs: Microsoft Picture It! Express and Professor Franklin's Instant Photo Effects. The combination is an appropriate starter set if you don't have any other image-editing tools. All told, the 697C is one of the best units in this roundup for light-duty print-

ing in the home or the home office.

Like the 697C, the 712C offers a full range of capabilities for multiple uses. The unit compares well against its sibling, particularly in the area of color graphics, and it's consistently faster as well. The 712C's photo output offers a bit more contrast than that from the 697C, though few people will notice this without a direct comparison. Our jurors judged this printer *good* during image quality tests. The 712C did very well on our speed tests, generally scoring in the top half of ink jets and even managing a near-laser-class score of 3.98 ppm on our 12-page Microsoft Word document. Bundled software is the same as for the 697C.

With its speed advantage, the 712C is a better choice for most people than the 697C—particularly if you print mostly text. And the 712C is certainly a good choice for the price.

The HP DeskJet 722C is a near-twin to the DeskJet 712C and is even faster.



This, combined with truly stunning photo output quality, makes this one of our favorite ink jets for home users. Hewlett-Packard has bundled the 722C with templates for Word and WordPerfect, Streetwise By Design, and Corel Print House and Photo House Select 2.0 for a range of home and small-business design projects.

On our tests, text was of laser quality, and the 722C is one of only three units whose output earned a rating of *excellent* from our jurors (the HP DeskJet 895Cse and 2000Cse Professional Series printers are the others). If you want a quick printer for home that can deliver both excellent text and photos, this is the printer you want.

MORE FOR BUSINESS

The HP DeskJet 895Cse Professional Series printer is targeted squarely at the SOHO market, with still faster rated print speeds and the same stellar output. Indeed, this is one of the true standouts in this year's roundup; the race between this and the Epson Stylus Color 850 (\$350) was a tough one to call.

In addition to the usual parallel-port connector you'll find a USB plug, which might make it easier to switch on the fly between a desktop and a notebook PC. The bundled software is geared toward business use. Office in Color, HP OEM Edition includes more than 200 templates for Microsoft Word and Excel for creating flyers, brochures, and the like. PhotoRecall, HP Special Edition will help manage photos, graphics, and clip art. HP Instant Delivery lets you receive and print specially formatted editions of popular newspapers over the Web. HP Web PrintSmart lets you combine pages from your favorite Web sites into a personal newsletter that you can download and print automatically.

Photo output closely matched that of the brilliant 722C, and our jurors rated the 895Cse the best ink jet we tested. On speed tests, the 895Cse was in the top tier of ink jets, though it wasn't as fast as the Epson Stylus 850. Overall, the 895Cse should be on your short list if you need the advantage in speed. It's one of the best ink jets we've seen, and our Editors' Choice for business use.

The HP DeskJet 1120Cse is also on target. This tabloid-capable printer is meant for small-business users who want to print their own brochures, small posters, wide spreadsheets, and the like along with standard business documents. It's an excellent multiple-use workhorse. The driver includes features to help users make the most of the large format, with specific design templates for brochures, handouts, booklets, and other documents. The booklet option automatically prints pages in the right order for a booklet.

Text from the 1120Cse was of near-laser quality—a touch too heavy, perhaps, but still good. Photo output was not

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quite as good as that of the top-ranked HPs but was still very good. Performance on our tests was a little faster than average. If you need a tabloid-size printer and want to use it for all your printing (and you don't need the speed of a laser printer), the 1120Cse will do the job handily.

The HP DeskJet 2000Cse Professional Series printer is the closest ink jet challenger to color lasers. Its claimed speed and cost per color page—2.5 cents for a typical text page and 5.2 cents for a color page with 15 percent coverage—rival color lasers (which cost \$2,000 more), and its 5,000-page-per-month duty cycle is also a match for most desktop lasers. Note, too, that the printer uses a separate cartridge for each color ink, further helping reduce per-page costs by letting you use all the ink in each cartridge. The 2000Cse comes with the same Office in Color, HP OEM Edition software you'll find bundled with the 895Cse.

What distinguishes this printer—and what makes it worth a fairly hefty price for an ink jet printer—is the speed, pure and simple. On our tests, the 2000Cse took a convincing first place among ink jets on most tests and often drilled well into laser territory, printing some of our text documents at over 5 ppm. That its output is among the best we saw is icing on the cake. These attributes go a long way toward making this the poor man's substitute for a color laser printer. —M. David Stone

Lexmark 1100, 3200, 5700 Color Jetprinter

1100: 3.5-ppm/1.5-ppm; 600 x 600 dpi; \$120 (\$90 after rebate). **3200:** 6 ppm/2.5 ppm; 1,200 x 1,200; \$180. **5700:** 8 ppm/4 ppm; 1,200 x 1,200; \$250. Lexington, KY; 800-539-6275, 606-232-2000; www.lexmark.com; 525 at www.pcmag.com/infolink.

● Like Canon Computer Systems, Lexmark International is trying to carve out a niche in the lower-price stratum of the ink jet market. Each of the three printers here is a solid value, and the Lexmark 3200 Color Jetprinter delivers the best text output at its price point.

With its single printhead and three-color ink system, the Lexmark 1100 Color Jetprinter is an update of last year's model 1000, with the addition of a paper

output tray. It ships with a color cartridge but no black ink supply (\$30 extra), so don't leave the store without one.

Operating the 1100 is straightforward. Just set the printer driver to the proper paper type and let the automatic settings adjust for optimal print quality. Bundled software includes Micrografx's Windows Draw 6 SE Printer Studio. As with its predecessor last year, we found the paper feed system somewhat troublesome, with occasional multiple-page feeds when the 30-sheet input tray was loaded with more than just a few pages.

Output from the 1100 was acceptable for a \$100 printer, but not great. Text on plain paper (using the included three-color cartridge) was grayish and fuzzy; switching to a dedicated black ink cartridge produced well-formed, dark text that would not, however, be mistaken for laser output. Colors were accurate, but



600-dpi photo images printed on glossy paper weren't as smooth as similar images from most other ink jets, showing noticeable graininess and some banding. Speed was not the 1100's strong point, either, but here it fared better than its low-priced competitors from Canon and Compaq Computer Corp. If you want a printer to pack off with your kid to college, never to be seen or heard of again, the 1100 Color Jetprinter is sufficient. But when you add the cost of the black cartridge, you're already at the price of a more serious printer such as the \$150 Epson Stylus 440.

The four-color Lexmark 3200 Color Jetprinter is a great leap up from the 1100 in print quality, speed, and general ease of use. Paper feeding with the 100-sheet

input tray is as it should be: uneventful. This printer comes standard with both black and color cartridges, and it's bundled with Micrografx's American Greetings CreatoCard SE and Windows Draw 6 SE Printer Studio.

In our labs, we found the 3200's text printing—always a Lexmark hallmark—to be excellent. The output was indistinguishable from laser-printed text and was the best we saw from a sub-\$200 ink jet. Photographic images printed with the \$44.95 (list) photo ink cartridge on glossy paper were smooth, with only minor banding. Our jury test awarded this printer a *good* rating for its photo output quality. The 3200 was a respectable performer in printer speed testing. For general-purpose printing in the home—or for light business use—the 3200 Color Jetprinter is a fine choice.

If you need a faster printer for a home office or small business, the Lexmark 5700 Color Jetprinter is an aggressively priced contender. The 5700's Accu-Feed paper handling system is borrowed from Lexmark's laser printer line. Robust and well designed, the system adds reliability by using a variable-pressure arm to keep the printer from feeding more than one sheet at a time from the 100-sheet input tray. The Lexmark Work-

shop CD-ROM for photos is a bundled software package, which includes GreetingCardMaker, LivePix SE, PhotoFantasy, PhotoImpression, PhotoPrinter, Post-it Notes Design, T-ShirtDesign Maker, and WebPrinter.

The 5700 produced laser-quality output on plain paper and very good color output on glossy paper in 1,200-dpi mode. The images were exceedingly smooth, with true color replication. Graphics samples showed occasional minor banding, though color reproduction was terrific. The 5700 was also faster than average for this roundup on our performance tests. We preferred the similarly priced (and slightly speedier) HP DeskJet 712C, but the 5700 Color Jetprinter is a attractive choice as well.—BB

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6 ppm/2 ppm; 1,200 x 600 dpi; \$170 (\$140 after rebate). Itasca, IL; 800-632-4636; www.nec.com; 526 at www.pcmag.com/infolink.

● Targeting entry-level small-office and home users, the NEC SuperScript 650C offers a decent feature set for an attractive price. The 650C is not a standout, but it delivers speed and image quality equal to those in its price range.

With only form-feed and power buttons on the front panel, the 650C uses software to handle most of the standard mode-switching tasks. The 650C's driver doesn't offer the wide array of image adjustments (such as separate color-saturation settings) that some of its competitors do but suffices for those who want to



The NEC SuperScript 650C is okay, but not great.

install the printer and then leave it alone. Five software programs from The Learning Company are bundled, including Calendar Creator and PhotoFinish.

Image quality on our tests was satisfactory, though the Olivetti-sourced print engine is a step behind those from Canon, Epson, and HP. Text was dense and well-formed but would not be mistaken for laser print. On the whole, text from the similarly priced Epson Stylus Color 440 was better. Skin tones and color details were excellent, but dithering dots were quite apparent in photo printouts. Moreover, in printing out transparencies, we discovered we had to feed sheets manually into the printer to prevent it from spooling more than one transparency at a time. On our jury tests for image quality, the 650C was rated *fair*. The bright spot here was print speed, which was in solid midrange territory for an ink jet.

If every penny counts in your home or office budget, the NEC SuperScript 650C

will do the trick for infrequent color printouts. But you're likely to want something better before long.—John R. Quain

Okidata OkiJet 2500

5 ppm/2.5 ppm; 1,200 x 600 dpi; \$240. Mount Laurel, NJ; 800-654-3282; www.okidata.com; 527 at www.pcmag.com/infolink.

● Targeted at budget-conscious small businesses that require only occasional photo-quality printouts, the Okidata OkiJet 2500 is outclassed by rivals in its price range.

The OkiJet can hold 125 sheets in its vertical paper-input tray and features four individual color ink cartridges. Rather than having to replace an entire \$40 four-color ink jet cartridge when one color runs dry, you can swap out the individual color cartridges in the OkiJet for around \$10 each. Operation of the printer is straightforward, with a limited control-panel display of four flashing lights to indicate low ink levels and a software driver that will convey the same information. The unit comes with a copy of Broderbund's popular Print Shop.

The OkiJet's text quality was acceptable but not up to that of others in its class. In color printing, the OkiJet tended to oversaturate the paper with ink. This means extra drying time before you can handle the output; the benefit is solid colors and bright hues in graphics. In photo printing, skin tones and other colors were reasonably faithful to the original image, although we noticed some softness and graininess throughout. This printer's photo output was rated *fair* on our jury tests, mostly because of its graininess.

On most speed tests, the OkiJet was a little slower than average. Shoppers will save \$40 by choosing the similar Xerox DocuPrint XJ6C instead. For an even better buy, consider the superior HP DeskJet 712C, which costs \$10 less.—JRQ

Xerox DocuPrint XJ6C, XJ8C

XJ6C: 5 ppm/2.5 ppm; 600 x 600; \$150. **XJ8C:** 8 ppm/4 ppm; 1,200 x 1,200; \$270. Rochester, NY; 800-832-6979; www.xerox.com; 528 at www.pcmag.com/infolink.

● Xerox Corp.'s pair of ink jet printers turned in satisfactory but undistinguished results. Better combinations of color qual-

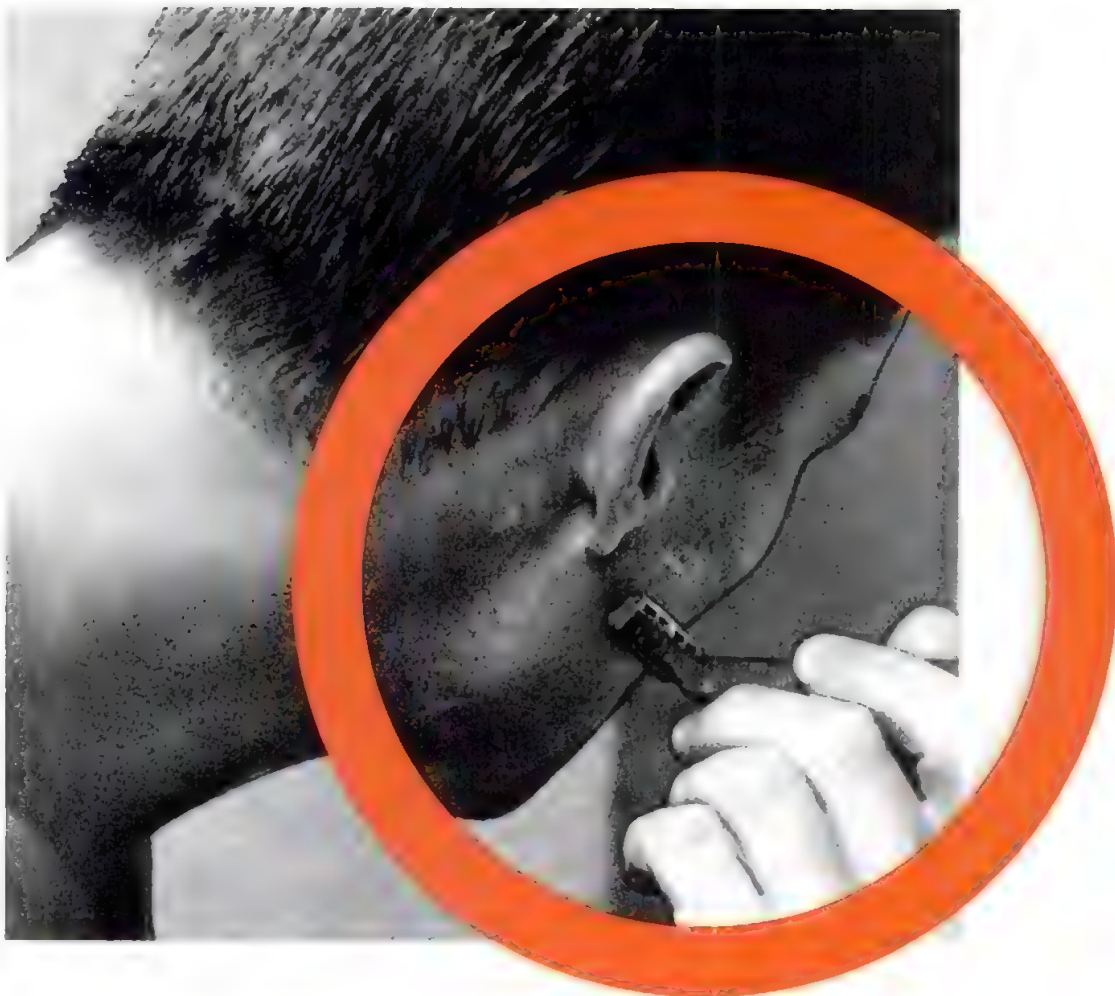
ity and print speed are available.

On the more affordable end is the Xerox DocuPrint XJ6C. The unit is aimed at home users and small-office start-ups, and although it may please some users, its print quality is outclassed by the competition. The XJ6C's vertical design and four individual color ink tanks are intended to save space and money. Each tank can be replenished as necessary without throwing out an entire three-color cartridge when only one color has run out. The software bundle includes image-editing applications from ArcSoft including PhotoBase, PhotoFantasy, and PhotoStudio.

The XJ6C's output is unremarkable. Text was good, though not of the laser quality we saw from others. Colors were fully saturated (sometimes slightly oversaturated), delivering deep tones in graphs and charts. There was some graininess and loss of detail in photographic printouts, however, and we also noticed dithering dots and a lack of crispness in fine gray-scale images. Our jurors ranked the output quality as *fair*. On our tests, the XJ6C was slower than the average ink jet. This printer provides the basics, but you might do better with similarly priced units from Canon, Compaq, Epson, HP, or Lexmark.

The Xerox DocuPrint XJ8C costs more and has a higher speed rating, but on our tests it was nearly identical in performance to its sibling. Devoid of front-panel controls, the XJ8C relies on software driver alerts and status reports to warn you about printing snags. One appealing driver feature is the automatic color mode, which does a respectable job of differentiating among line art, photographs, and gray-scale images on the fly.

Text output was slightly better and approached laser quality. Color images (using the special photo ink) were also marginally better, with less dithering and added luster, but still not good enough to rate better than *fair* with our jury. Image quality from the XJ8C is slightly better, but the difference between these two printers may not be great enough to justify the additional investment. If you're in the market for a small-business printer that can perform home-oriented color tasks, consider the much better all-around packages from Epson and HP before committing to either of these Xerox entries.—JRQ



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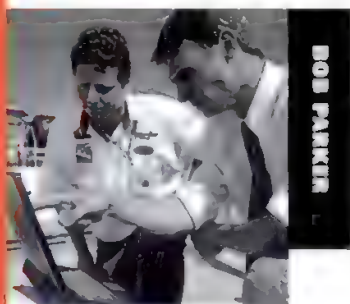
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—PC World, Ranked #1, "Best Buy," April 1998

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—William Goins, III



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Model Name	TREK ² 233	TREK ² 233	TREK ² 266	New! TREK ² 300
Processor	Intel® Pentium® II processor 233MHz	Intel Pentium II processor 233MHz	Intel Pentium II processor 266MHz	Intel Pentium II processor 300MHz
Cache	512KB L2 pipeline burst cache	512KB L2 pipeline burst cache	512KB L2 pipeline burst cache	512KB L2 pipeline burst cache
RAM	32MB SDRAM	64MB SDRAM	64MB SDRAM	64MB SDRAM
Hard Drive	3.2GB hard drive	3.2GB hard drive (removable)	3.2GB hard drive (removable)	3.2GB hard drive (removable)
Monitor	12.1" SVGA TFT display	14.1" XGA TFT display	14.1" XGA TFT display	14.1" XGA TFT display
Extra Storage	3.5" floppy disk drive	3.5" floppy disk drive (dedicated bay)	3.5" floppy disk drive (dedicated bay)	3.5" floppy disk drive (dedicated bay)
CD-ROM	24X CD-ROM drive	24X CD-ROM drive (dedicated bay)	24X CD-ROM drive (dedicated bay)	24X CD-ROM drive (dedicated bay)
Graphics	4MB AGP graphics accelerator	4MB AGP graphics accelerator	4MB AGP graphics accelerator	4MB AGP graphics accelerator
Sound System	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone	Built-in stereo speakers & microphone
Warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty	5-year/1-year Micron limited warranty
Software Included	Microsoft® Windows® 98 System Wizard Mobile Client™ Norton AntiVirus	Microsoft Windows 98 Microsoft Office Small Business Edition System Wizard Mobile Client™ Norton AntiVirus	Microsoft Windows 98 Microsoft Office Small Business Edition System Wizard Mobile Client™ Norton AntiVirus	Microsoft Windows 98 Microsoft Office Small Business Edition System Wizard Mobile Client™ Norton AntiVirus
Also Includes:	Zoomed Video capable Li-Ion battery (dedicated bay) Microphone, stereo line-in/out jacks Touchpad pointing device CardBus ready S-Video & NTSC out; MPEG compatible WaveTable/3D Positional Sound 2-way fast infrared port 2 Type II/1 Type III PCMCIA slots 2-USB, parallel, serial, VGA, PS/2 ports	Zoomed Video capable Li-Ion battery (dedicated bay) Microphone, stereo line-in/out jacks Touchpad pointing device CardBus ready S-Video & NTSC out; MPEG compatible WaveTable/3D Positional Sound 2-way fast infrared port 2 Type II/1 Type III PCMCIA slots 2-USB, parallel, serial, VGA, PS/2 ports	Zoomed Video capable Li-Ion battery (dedicated bay) Microphone, stereo line-in/out jacks Touchpad pointing device CardBus ready S-Video & NTSC out; MPEG compatible WaveTable/3D Positional Sound 2-way fast infrared port 2 Type II/1 Type III PCMCIA slots 2-USB, parallel, serial, VGA, PS/2 ports	Zoomed Video capable Li-Ion battery (dedicated bay) Microphone, stereo line-in/out jacks Touchpad pointing device CardBus ready S-Video & NTSC out; MPEG compatible WaveTable/3D Positional Sound 2-way fast infrared port 2 Type II/1 Type III PCMCIA slots 2-USB, parallel, serial, VGA, PS/2 ports

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Model Name	Millennia C300	Millennia 350	Millennia 400	New! Millennia 450	New! Millennia 450 MAX
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Cache	128KB internal L2 cache	512KB internal L2 cache	512KB internal L2 cache	512KB internal L2 cache	512KB internal L2 cache
RAM	32MB SDRAM	64MB 100MHz SDRAM	64MB 100MHz SDRAM	64MB 100MHz SDRAM	128MB 100MHz SDRAM
Hard Drive	4.3GB Ultra ATA hard drive	10GB Ultra ATA hard drive	10GB Ultra ATA hard drive	10GB Ultra ATA hard drive	14.4GB 7200 RPM Ultra ATA hard drive
Monitor	15" Micron 500Hz monitor (13.8" display)	17" Micron 700Hz monitor (15.9" display)	17" Micron 700Hz monitor (15.9" display)	17" Micron 700Hz monitor (15.9" display)	19" Micron 900Lx monitor (18" display)
DVD/CD-ROM	32X max speed CD-ROM drive	32X max speed CD-ROM drive	32X max speed CD-ROM drive	32X max speed CD-ROM drive	DVD-ROM drive and decoder card***
Modem	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**	3Com/U.S. Robotics 56K WinModem**
Graphics	nVidia Riva 128, 8MB SGRAM 3D AGP graphics	nVidia Riva 128, 8MB SGRAM 3D AGP graphics	nVidia Riva 128, 8MB SGRAM 3D AGP graphics	nVidia Riva 128, 8MB SGRAM 3D AGP graphics	Real 3D StarFighter 1740, 8MB AGP graphics
Sound System	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound	PCI 64-voice Wavetable sound
Warranty	5-year/3-year Micron Power® limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty	5-year/3-year Micron Power limited warranty
Software Included	Microsoft® Windows® 98 Microsoft Home Essentials Microsoft Power Pak Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus	Microsoft Windows 98 Microsoft Office 97 Small Business Edition Norton AntiVirus
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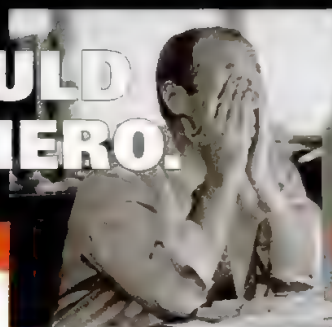
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u're starting to scratch the surface. Let's face it, when you're crawling around under someone's desk in a jungle of twisted cables because they want to see the dancing baby
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HL-1040: 10 ppm; 600 x 600; \$300. **HL-1050:** 10 ppm; 1,200 x 600; \$400. Bridgewater, NJ; 800-276-7746, 908-704-1700; www.brother.com; 529 at www.pcmag.com/infolink.

● Lightning-fast and easy to use, these two monochrome lasers from Brother International offer low selling prices, low operating costs, and solid text output for business buyers. Both should be on your short list.

We had no problem setting up either unit, thanks to the thorough, illustrated manuals. Because you don't have to replace the drum each time toner runs out, these Brother units deliver the lowest per-page operating costs of the lasers we tested: 1.4 cents for a typical text page, versus more than 2 cents for most others. Four LEDs indicate the printer's status; conditions needing attention, such as low toner, are reported to your PC screen via the driver. Both printers handled envelopes (which can measure up to 9 by 12 inches) well and resisted jamming, even with folded sheets of paper.

Text output from both units at 600 dpi was clean, with dark blacks and smooth curves. But graphics quality at 600 dpi was less than ideal. Blacks were dark, but what looked like streaks from the roller came out on our test gray-scale image. Intermediate grays were a bit muddy, but highlights held tone well.

The Brother HL-1040 is one of the most

affordable lasers in this roundup, putting it within reach of home and home-office users who want a quick laser printer rather than an ink jet. It was one of the fastest lasers on our tests and hummed along at near-rated speed on long text documents.

Stepping up to the Brother HL-1050 gets you twice the base RAM (4MB, upgradable to 36MB) of the HL-1040, PCL 6 emulation, and USB connectivity. Output quality was the same as the HL-1040. Throughput was quick, but somewhat slower than the HL-1040. Brother faults the newer, less optimized PCL 6 drivers.



Brother's affordable HL-1050 is a text workhorse.

The HP and NEC lasers here did a better job of printing graphics. But for a text workhorse at an affordable price, either of these Brothers is a good choice.—James Karney

HP LaserJet 1100, 6P

1100: 8 ppm; 600 x 600; \$400. **6P:** 8 ppm; 600 x 600; \$900. Palo Alto, CA; 800-527-3753; www.hp.com; 524 at www.pcmag.com/infolink.

● Hewlett-Packard's popular LaserJet series has a reputation for good performance and ease of use, and the two models submitted for this roundup are worthy examples. We like the expandability and value of the HP LaserJet 1100, but found better bargains than the HP LaserJet 6P in the NEC SuperScript 870 (\$350) and the 12-ppm Xerox DocuPrint P12 (\$700).

Both LaserJets share a simple installation procedure: Just install the toner cartridge and paper, hook up the parallel and power cables, and load the drivers from a CD-ROM. The average user should have no problems getting up and running.

The LaserJet 1100, aimed at SOHO and business users, stands out for its expandability: An optional add-on module (\$150) turns it into a multifunction device with monochrome scanning and copying capabilities. (For details, see the review of the LaserJet 1100A in this story's multifunction section.) The manual is complete and well written, with plenty of illustrations. Don't expect a lot of controls on the printer's front panel, however; there's only a power button that looks like a recessed green marble, plus ready and alarm LEDs.

Output quality in our labs was very good for text, with solid blacks and smooth type. Graphics were quite good for a low-end laser, though we wouldn't recommend the 1100 for serious graphics output. Gray-scale images showed reasonable tonal range, though we did notice banding in some gradients. Tested speed in our labs was mid-pack for its rated engine speed. All told, this is a fast, well-thought-out laser printer for users who print a lot of text. And the expandability option adds more value, making it especially attractive for buyers who aren't ready to commit to the higher cost of a multifunction device.

For more heavy-duty use, the HP LaserJet 6P combines speed, output quality, and connectivity features into an intuitive—if somewhat expensive—package. The 6P's feature-rich basic configuration

HOW WE RATED LASER PRINTERS

	Price	Text quality	Graphics quality	Overall speed	Vendor grade*
Brother HL-1040	\$300	Excellent	Fair	Excellent	C
Brother HL-1050	\$400	Excellent	Fair	Good	C
HP LaserJet 1100	\$400	Excellent	Fair	Good	A
HP LaserJet 6P	\$800	Excellent	Good	Good	A
Kyocera FS-600	\$400	Good	Fair	Fair	Not rated
Kyocera FS-800	\$500	Good	Good	Good	Not rated
Minolta PageWorks 8L	\$380	Good	Good	Good	Not rated
Minolta PageWorks 8e	\$580	Good	Good	Good	Not rated
NEC SuperScript 870	\$350	Excellent	Excellent	Excellent	B
Okidata OkiPage 6e	\$250	Good	Good	Poor	C
Okidata OkiPage 8e	\$350	Good	Good	Good	C
Okidata OkiPage 10i	\$500	Excellent	Fair	Good	C
Xerox DocuPrint P8	\$300	Excellent	Good	Good	D
Xerox DocuPrint P12	\$700	Excellent	Excellent	Good	D

* Service and Reliability survey PC Magazine, July 1998

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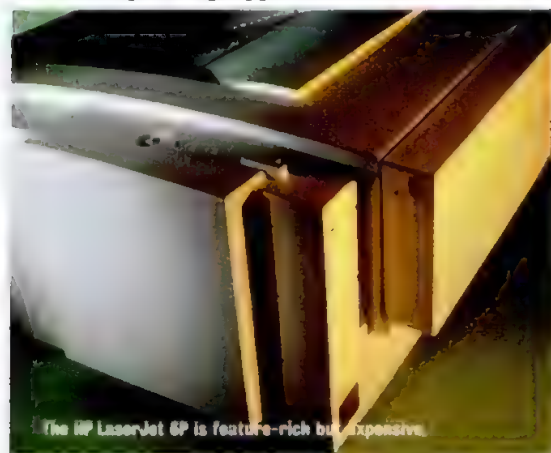
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includes two paper sources (one for up to 100 sheets and the other for up to 250), two bidirectional printer ports, one LocalTalk connection, and an IrDA infrared port. The 6P can also accept one of four external JetDirect network interface modules, so you can share it in a small workgroup.

An able performer, the 6P was at or near the top among 8-ppm units on most

means you'll have to replenish only the toner, not the whole housing. This design not only helps save the environment but also helps lower per-page costs to around 1.7 cents for a typical double-spaced page (most other lasers here cost 2 cents or more per page). And you needn't worry about spills; the toner cartridge is easily handled without spilling black powder all over the floor.



The Kyocera FS-600 lacks some amenities, such as an LCD to tell you what's happening. This occasionally caused confusion in our labs—for example, when the jam alert light started blinking during our tests. The malfunction turned out to be not a paper problem but a poorly seated toner cartridge. As for output quality, text was sharp and clear, and the printer's KIR (Kyocera Image Refinement) technology kept letters crisp and legible.

of our tests. It delivered very clean text, and graphics were sharp, with good tonal range and solid blacks. There was slight banding on some steep gradient fills, but gray-scale images printed very well for a 600-dpi device. Highlights were handled well, and midrange tones had good separation. The 6P won't disappoint, but be sure to cross-shop the NEC and Xerox printers, which offer similar (or better) speed and expandability at more attractive prices.—JK

Kyocera FS-600, FS-800

FS-600: 6 ppm; 600 dpi; \$400. **FS-800:** 8 ppm; 600 dpi; \$500. Somerset, NJ; 800-232-6797; www.kyocera.com; 530 at www.pcmag.com/infolink.

● These Kyocera lasers are reasonable choices for home or home-office users who need to print out a moderate amount of monthly paperwork. Of the two, the FS-800 is the better bargain.

Each model is neatly tucked into a small footprint, with a bottom paper cassette that holds 150 sheets and a top-out, face-down tray that saves desktop space. Each unit is rated for a rather high monthly duty cycle of 8,000 pages. The company's cartridge-free technology features an amorphous silicon print drum with a long-life fuser and developer that are rated for the life of the printer. That

But there were a few problems. In attempting to resolve our gray-scale image test file, the FS-600 stubbornly refused to print. Pressing the status button resulted in the image being incorrectly printed on two different pages—a problem Kyocera's technical-support staff was unable to resolve.

On our speed tests, the FS-600 delivered respectable throughput for a 6-ppm device. But for the same price or less, you can opt for one of the speedier 8-ppm units, such as the HP LaserJet 1100 or NEC SuperScript 870.

Testing proceeded more smoothly with the 8-ppm Kyocera FS-800. Boasting Kyocera's own PostScript Level II interpreter and an additional 2MB of memory (for a total of 4MB), the FS-800 is easier to use than the FS-600. It's equipped with the LCD that the FS-600 lacks, and most of the messages that appear on the 32-character display are instantly understandable.

During testing, the FS-800 was one of the quicker 8-ppm models. This model also delivered the test gray-scale image without a hitch. If you're looking for a solid, plucky little page printer that won't demand too much of you or your office real estate, consider the Kyocera FS-800.—JRQ

Minolta PageWorks 8L, 8e

8L: 8 ppm, 600 x 600; \$380 street. **8e:** 8 ppm; 600 x 600; \$580. Mahwah, NJ; 888-264-6658, 512-490-2416; www.minoltaprinters.com; 531 at www.pcmag.com/infolink.

● Respectable speeds, intuitive controls, a high duty cycle, and a wealth of useful business features distinguish these affordable laser printers from many competitors.

For SOHO users and small businesses with moderate output needs, the Minolta PageWorks 8L is tempting. Installing it is easy, and its intuitive driver offers a range of printing options, including booklets, watermarks, and customizable thumbnails. The Adobe PrintGear processor lowers costs while delivering respectable speeds. Image quality was reasonable on our tests; text at 600 dpi was impressive. Graphics were acceptable but not stellar; our gray-scale photo image printed with a light streak, no matter the settings. All told, the 8L is compelling, especially for the price.

The Minolta PageWorks 8e is a more heavy-duty, high-output printer than most here. It sells for a reasonable price and is a carefully crafted match for its business audience, featuring a rated duty cycle of 15,000 pages per month (6,000 is more typical in this class), 650 sheets of input capacity standard (versus 150 to 250 for other units), and an internal NIC option (\$270). Installing the 8e gave us a bit of trouble, however: Although our Windows 98 testbed recognized the device, the Plug and Play mechanism couldn't detect the special driver on the CD. We also couldn't get the bottom paper tray working; it would feed the first page, then jam. We tried switching paper types and spent time on the phone with a Minolta technician, but to no avail. Minolta sent us a replacement unit, but its bottom tray fared no better. The top tray worked fine.

On our speed tests, the 8e was about average for an 8-ppm laser. Output quality was on a par with that from other units: 600-dpi text looked terrific, and graphics printed well at the default settings, although choosing the Fine Art Dark mode caused some minor smearing. Except for the bothersome lower tray, we were generally pleased with this model. You'll want to look closely at competitors such as the NEC SuperScript 870 (\$350) and Okidata Okipage 10i (\$500), but the 8e is a fine choice.—Michael Mathog

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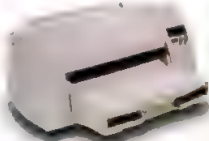
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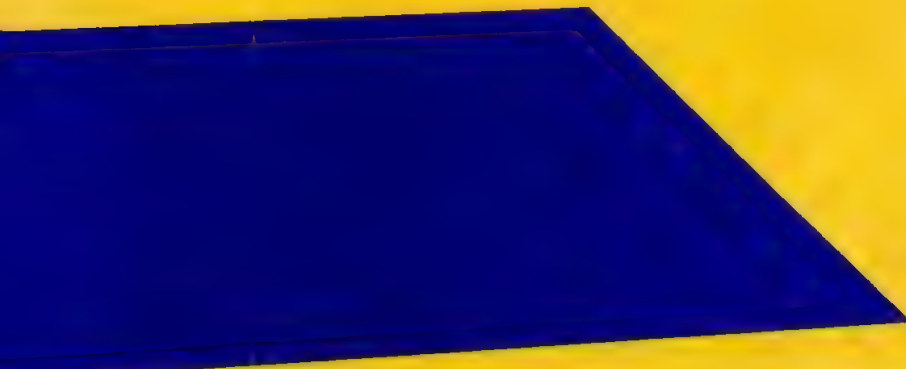
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NEC SuperScript 870

8 ppm; 600 dpi; \$350. Itasca, IL; 800-632-4636; www.nec.com; 526 at www.pcmag.com/infolink.



The NEC SuperScript 870 is the successor to last year's Editors' Choice-winning SuperScript 860, with the same rated speed and resolution but a lower price. The improvements may be evolutionary, not revolutionary, but they're significant enough to earn this SOHO-oriented model our Editors' Choice

award in the laser category.

Setup was simple, and the PrintGear driver offers lots of handy features, including a toner-sparing draft mode, multiple thumbnails per page, and watermarks. The printer also includes HP PCL 4.5-compatibility. The bundled CD includes Adobe Type Manager and Adobe Acrobat Reader, plus a collection of clip art and extra fonts. Thrifty users will like the choice of a high-capacity 6,000-page toner cartridge (\$109) in addition to the standard 3,000-page cartridge (Minolta is the only other vendor

in this roundup to offer this option). This drops printing cost to 1.8 cents per page, versus more than 2 cents per page for most others. Also unlike most others, you can augment this printer's 150-sheet input capacity with a 500-sheet bin (\$169 list) and add an internal network interface card (\$249 list) to share the printer when the time comes.

In terms of image quality, the SuperScript 870 did not disappoint. Text was clean and legible even in minuscule point sizes, and graphics output results were stunning. Continuous tones were smooth

PERFORMANCE TESTS

Laser Printers



On just about every test, the 10-ppm Brother HL-1040 came out on top. The Xerox DocuPrint P12, rated at 12 ppm, showed the best raw engine speed but couldn't handle small or graphical jobs as well as the HL-1040.

In most cases, we found that the performance of the desktop laser printers tracked fairly closely with their rated page-per-minute (ppm) speeds in printing large jobs. But of course, the raw ppm alone does not tell the whole story about a printer. Desktop printers do not always print 50-page reports. In fact, one- or two-page jobs are more common for this category of printers. We measured each printer's quickness associated with printing a single page as well as its steady-burn speed in printing a multipage job. We also looked at how fast the printer drivers returned the application control back to the user. Only then did we begin to see the subtle differences that distinguish truly fast printers.

Considering its 12-ppm rating, which is the highest in this roundup, on the surface the Xerox DocuPrint P12 looks like the speed winner. In fact, the printer did perform close to its rated ppm in printing a 43-page Word document on our informal test (not shown). And the Xerox printer was the fastest in printing 12 pages of pure text (our Microsoft Word Text test), at 9.88 effective ppm. But when it comes to printing a small jobs or graphics-intensive job, the Brother HL-1040, rated at 10 ppm, was much more suitable to the task. The HL-1040 was the fastest printer on all our tests except for the 12-page Word Text test. Surprisingly, the HL-1040 was even significantly faster than its sibling, the HL-1050, which is

► The variance in performance on our Microsoft Publisher test was narrower than on any other, falling within a small range between 1 and 3 effective ppm, except for the Brother HL-1040, which distanced itself from the pack. We saw the widest variance on our 6-page PowerPoint test, with the Brother HL-1040 posting the top speed. More surprising was the 5.43 ppm disparity between the HL-1040, with its PCL 5e driver, and the slower HL-1050, with its PCL 6 driver.

powered by a faster processor (66 MHz versus 16 MHz) and has twice the RAM (4MB versus 2MB). Brother representatives suspect that the more optimized PCL 5e driver of the HL-1040 helped it edge out the HL-1050, which uses a newer PLL 6 driver.

Our Editors' Choice in this category, the NEC SuperScript 870, demonstrated solid performance throughout the tests, excelling especially in printing small-size jobs and Excel spreadsheets. Both entries from Hewlett-Packard, the LaserJet 6Pse (upgraded to 10MB of memory for our tests) and LaserJet 1100se, were average on all test categories. At the bottom, two 6-ppm-class printers, the Okidata OkiPage 6e and the Kyocera FS-600 (upgraded to 6MB) were barely faster than the top ink jets. The third 6-ppm-class printer, the OkiPage 6ex, did slightly better with its memory upgraded to 8MB.—*Analysis written by S. Jae Yang. Special thanks to Pete Duff of Genoa Technology Inc.*

How We Tested

We asked the vendors to recommend the driver and resolution settings for each printer that typical users are expected to use. We measured the "click-to-clunk" time, defined from the moment the OK button in the print dialog box is clicked to the moment the last page is released to the output tray. Therefore, the test results here represent the performance that users actually experience. In the table, we present the data in "effective pages per minute," calculated on the basis of the click-to-clunk time, which includes the first-page-out delay at the beginning of each print job.

For measuring printer speed, we implemented PageSense II Printer Application Performance Test System (APTS), an auto-

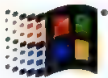
Continues on page 154

LASER PRINTERS

Effective ppm High scores are best. denotes Editors' Choice	Rated engine speed (ppm)	Microsoft Publisher 7 page	Microsoft PowerPoint 6 pages
Kyocera FS-600	6	1.45	1.86
Okidata OkiPage 6e	6	1.08	3.47
Okidata OkiPage 6ex	6	1.93	3.77
HP LaserJet 1100	8	1.43	0.99
HP LaserJet 6P	8	1.62	3.86
Kyocera FS-800	8	1.67	1.83
Minolta PageWorks 8L	8	2.35	4.99
Minolta PageWorks 8e	8	1.65	2.00
NEC SuperScript 870	8	2.72	6.58
Xerox DocuPrint P8	8	3.07	6.14
Brother HL-1040	10	3.82	8.13
Brother HL-1050	10	2.43	2.70
Okidata OkiPage 10i	10	1.50	4.89
Xerox DocuPrint P12	12	3.07	7.45

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and steady, with only slight horizontal banding. Gray scales were rendered with such fine dither patterns that, at arm's length, pictures looked like photographic prints. Powered by a 60-MHz Adobe Print-Gear processor, the 870 was one of the faster lasers in our tests, keeping pace even with the 10-ppm machines on some tests.

If you're looking for satisfying speed at an unbeatable price with even more unbeatable output quality, the NEC SuperScript 870 is an excellent pick—even better than last year's Editors' Choice.—AP

Okidata OkiPage 6e, 6ex, 10i

6e: 6 ppm; 300 x 1,200; \$250. 6ex: 6 ppm; 800 x 1,200; \$350. 10i: 10 ppm; 600 x 1,200; \$600. Mount Laurel, NJ; 800-654-3282, 609-235-2600; www.okidata.com; 527 at www.pcmag.com/infolink.

● These printers from Okidata are built around the company's monochrome LED print head, designed to improve quality and last longer than a standard laser. All three produced consistently high-quality output in our labs, and the 6ex was fairly speedy for a 6-ppm machine. The best buy is the heavy-duty OkiPage 10i.

The no-frills OkiPage 6e is the least expensive laser-class printer we tested, and it's an acceptable choice for budget-conscious users who want better speed and lower operating costs than an ink jet. Setting up the 6e was simple, and the driver is stocked with useful features, providing a wide array of printing options including banding adjustment, dithering texture and pattern adjustment, and a status monitor. Along the settings, the control panel shows you an example of what you've selected so you can see if you like it. There was only one minor glitch: Set-

PERFORMANCE TESTS

Continued from page 150

mated test developed by Genoa Technology, a Moorpark, California-based company that specializes in developing automated tests for printers and fax machines. We installed all printers on a Pentium II/300-based NEC Direction with 64MB of RAM and a 6GB EIDE hard disk, operating on Windows 98 set to 1,024-by-768 at true color. We set the parallel port to the enhanced capability port (ECP) mode and set the spooling mode to EMF, unless the vendor specified otherwise. We disabled any and all printer power management features.

The PageSense II Printer APTS uses the Visual Test as the programming platform for automating the application-based printer testing. The system uses an LED-based sensor device that detects the pages produced and released by the printer. PageSense II measures the return-to-application time and the time to print each page as detected by the sensor.

The Microsoft Word Text and Graphics tests measure the printer's speed in using Microsoft Word 97 to print a 1-page letter with a graphic letterhead, and a 12-page document with heavily formatted text and graphics. The graphics consist of two half-page bitmapped images: one a photograph, the other an image with a large amount of black.

The Microsoft Word Text tests measure the printer's speed in using Microsoft Word 97 to print a 1-page text document consisting of monochrome text and a 12-page all-text document containing Arial, Times New Roman, and Courier TrueType 12-point fonts, unstyled.

For the Microsoft Excel test, we printed a two-page Microsoft Excel 97 spreadsheet,

much like those used in office environments, with tables and various types of graphs in color.

The one-page Microsoft Publisher newsletter document contains various typefaces and font sizes as well as photographic images.

For the Microsoft PowerPoint tests we printed six typical presentation slides from Microsoft PowerPoint 97, on both plain-paper and transparency media. The slides contained a demanding mix of text, graphics, and complex background patterns, typical of many business presentations.

LASER PRINTERS

Effective ppm High scores are best.	Rated engine speed (ppm)	Microsoft Word Text and Graphics		Microsoft Word Text		Microsoft Excel
		1 page	12 pages	1 page	12 pages	2 pages
Kyocera FS-600	8	2.18	3.89	2.54	6.17	3.29
Okidata OkiPage 6e	6	0.90	5.00	1.54	4.79	2.50
Okidata OkiPage 6ex	6	3.44	8.88	3.39	8.84	3.48
HP LaserJet 1100	8	2.76	4.80	3.37	7.94	4.00
HP LaserJet 8P	8	2.47	N/A	3.14	7.12	4.44
Kyocera FS-600	8	2.82	4.89	3.16	7.32	4.30
Minolta PageWorks SL	8	2.84	5.92	2.82	8.87	4.18
Minolta PageWorks 8e	8	3.06	4.45	3.21	7.27	3.90
NEC SuperScript 870	8	4.22	7.35	3.78	7.28	5.44
Xerox DocuPrint P8	8	4.53	6.93	3.45	7.01	4.92
Brother HL-1040	10	4.81	6.88	4.90	8.06	5.08
Brother HL-1050	10	3.88	6.77	3.15	8.97	6.38
Okidata OkiPage 10i	10	2.50	7.47	1.48	7.08	2.77
Xerox DocuPrint P12	12	2.98	8.46	2.90	9.88	3.11

N/A—Not applicable: The HP LaserJet 8P's page formatting created a 13-page file from our 12-page document.

▲ The results from the 1-page Microsoft Word Text and Text and Graphics can be attributed to the printer's quickness in responding to a print request. The raw print engine speed is less relevant in this test. The Brother HL-1040 was the swiftest in firing up the print engine to generate a simple 1-page job. The NEC SuperScript 870 and Xerox DocuPrint P8 were also quick on these tests. The Okidata OkiPage 6e and OkiPage 10i were the slowest at producing one-page jobs.

The 12-page Word Text test is a good indicator of the mechanical print engine speed. In general,

most printers' performance on this test reflected their rated engine speed. The few subpar performances belonged to the OkiPage 6e and OkiPage 10i. At 4.79 effective ppm, the OkiPage 6e's speed is as slow as that of a fast ink jet. With a frustrating first-page-out delay, the OkiPage 10i achieved only 71 percent of its 10-ppm rating on this test. The Xerox DocuPrint P12 was the best on this test at 8.88 effective ppm, but came up far short of its 12-ppm rating.

Performance on our 12-page Text and Graphics test can be attributed mainly to the driver efficiency

and the printer CPU's rasterizing performance. The Brother HL-1040, the NEC SuperScript 870, the three Okidata printers, and the two Xerox printers demonstrated good performance in handling the graphically intensive job. Surprisingly, the SuperScript and the OkiPage 6e and 10i performed slightly better on the 12-page Text and Graphics test than on the 12-page Text test. We do not report results for the LaserJet 8P on 12-page Word Text and Graphics test, because the HP printer's PCL 6 driver uniquely printed the 12-page document in 13 pages, making the test results not comparable.



FOCUS ON YOUR CUSTOMER

Customer-focused, customer-driven. Over the past decade, the giants of Corporate America have made the customer their strategic centerpiece, investing huge sums in information technology to help them improve their customer relationships.

And, what they've been saying is, 'We have to start treating our customers like small businesses do...with the same personal attention to their needs and the same ability to customize a product or a service.'

While big businesses are using technology to play catch up with companies with one, five, ten, or 20 employees, small businesses all over the world are finding out they can use those same solutions to build their advantage.

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Software solutions can help small businesses serve their customers better than ever, while at the same time helping them improve their own productivity. There are software solutions that not only put the power of information technology at their fingertips, but also protect customers from the problems that systems can cause.

Symantec has spent nearly two decades providing such solutions to individuals, businesses and other institutions around the world, making them more productive and keeping their computers safe and reliable — anywhere, anytime.

"With such revolutionary developments as corporate downsizing, computing and the Internet, the number of small businesses around

you more touch and feel when it comes to your customers?

Understanding

Customer-driven means that a business offers its customers products and services they really need, rather than presenting "a product in search of a market." The price is right; the packaging and shipping is the way they want it; their operation is 24 hours a day, so your support is too. The best businesses are the ones that understand their customers well enough not only to see all this, but also to see what's coming around the bend.

It's never been an easy task. You need to know your customer base by market or geographic segment, but that's not enough. You need to

tools can help you maintain the professionalism and personal touch you've been known for, reminding you and your staff about important customer dates and events.

Responsiveness

Responsiveness on a day-to-day basis says you provide customers with the answers they need when they need them. So sales and service people — no matter where they are — must have instant, easy access to customer databases and the ability to transmit quotes, presentations, and even training programs to customer sites. Access can also be speeded by technology that, for instance, enables caller ID to bring up the record before the sales or service person says "good morning."

It doesn't matter what information your customer needs and how fast, there's a communication vehicle for getting it there and you have to use it all: e-mail, voice mail, fax, overnight delivery. For instance, computer-to-fax is the fastest way to get your customers hard copy. We're talking about hard copy you send from your computer that might contain a just-assembled combination of the latest promotions and product illustrations.

Further, your customers should be able to access your systems to obtain the same information via e-mail or "fax on demand."

Voice mail? It's your image, they say, and technology exists for any size company to make sure you sound right, respond quickly, and keep a record of calls and faxes.

Productivity

Being able to provide your customers with better products and ever higher levels of service, being

Be understanding, responsive, productive and protective. This is what being customer-driven is all about.

the world has exploded," says Symantec's Dana Siebert, VP, Americas. "This is great because small businesses have always been a major source of innovation and service. A primary goal for companies like ours has to be to help level the playing field for them and contribute to their growth.

"What we're saying here is they have an advantage — their understanding of and responsiveness to their customers — and we think we can help them keep it."

The Touch and Feel of Technology

What does it mean to be customer-focused and customer-driven? How can technology give

you know your customers individually and they need to feel that you do — that you know their business, you know them as people.

For instance, to create winning proposals over and over again, you want your customer's plans and the history of your relationship at your fingertips. We're not only talking volume, credit history, and the bottom line, but also the nuances of how you have worked together.

Technologically, both the top-down planning and the individual interaction require a customer database: an information file on your customers and their accounts — the notes, the phone discussion logs, the presentations and proposals.

As your company grows, software

able to develop and retain close relationships with individual customers as your customer base grows — all this carries a cost to your business. You can't stay customer-driven as we've described if your resources are strained and your bottom line suffers.

The technology solutions we've noted above — the customer and prospect database, word processor, e-mail messaging and other communications tools such as computer-to-fax and the calendar — are also crucial productivity tools for your organization, allowing them to be responsive to customers literally at the push of a button.

To improve ease-of-use, while safeguarding your investment in new and older computing equipment, such tools must operate on all major computing platforms.

These tools are win-win solutions for the front lines of your business — the people who plan and deliver what the customer needs. You also need technology that protects your business and your customer's, and solutions exist for your back office to provide these safeguards.

Protection

Flash...computers are vulnerable and fallible. They crash, wiping out that 10-page proposal you hadn't saved. They can get viruses. Installing new programs can mess up your system. Worse, you can wipe out data on your customer. And, electronically connected to your customers, you can send them a virus that wreaks havoc on their systems.

The good news is that technology solutions exist to fend off these problems.

Small Business Solutions



ACT!™ home connects your relationships and results. This customer and contact management software provides instant access to critical information about your customers and appointments and triggers important items to remind you of important dates. ACT! supports Internet and e-mail access and lets you share information with your team.



WinFax PRO™ gives you hands-free faxing right from your computer, allowing you to send professional-quality faxes, including material from your ACT! databases, to one or more customers. The software is enhanced by scheduling faxes for offpeak hours. WinFax Pro faxing enables WinFax Pro to share its modem and phone line with other WinFax Pro copies on the network.



TalkWorks PRO™ makes a more professional image for small businesses with up to five employees. This voice and fax communications software provides fax-on-demand, enabling your customers to dial your computer and initiate faxes of proposals, price sheets, and other information. Away from your office? TalkWorks PRO can send you messages or color images. Other features include multimedia and call management, tracking all calls and faxes.



pcAnywhere™ helps you keep building customer relationships in the matter where you are. From your field office in Detroit, you can carry on electronic sessions with our customers in New York, sending them training programs or presentations from your laptop or the corporate computer in Chicago. Similarly, pcAnywhere lets you access customer data at the home office. Many security features are built in.



Norton AntiVirus™ eliminates today's and tomorrow's viruses. Norton AntiVirus is the best protection for you and any customers you are connected to electronically. PC Magazine, in giving this product the Editor's Choice award this year, called it "the best combination of virus protection, performance, and ease-of-use." Testing laboratories confirm that it provides 100% detection of "in the wild" viruses from any source, such as the Internet, floppy disks, and shared files.



Norton Utilities™ provides unrivaled problem-solving power and control by detecting, repairing, and intercepting most computer problems. A trusted solution for more than 15 years, Norton Utilities continuously monitors your system so you don't have to guess which utility to launch when there's a problem. Worried about crashes and disaster-recovery downtime? As PC Magazine has stated, Norton Utilities is "the industry leader" in preventing system crashes—done three as effective as compression—and provides advanced disaster-recovery capabilities.



Norton Ghost™ backup is the safest way to move or remove programs and files. It saves almost the latest and maintains custom settings for programs that are moved or moved. This can always restore what you've just discarded, after compressed backups for every workflow are saved. The HotCommander feature lets you test drive new programs safely.



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COVER STORY

Laser Printers

ting the watermarks off-center had no effect; they always printed in the middle of the page. Like other bare-bones lasers, the unit lacks a control panel, and the input capacity is a rather paltry 100 sheets.

In our labs, image quality was good. The company's patented smoothing technology, which varies the size and placement of dots to reduce jaggies, produced sharp text and good graphics output with smooth gradations, despite a few flaws in gray-scale images. On our speed tests, the 6-ppm 6e was a lackluster performer. Still, if cost is your primary concern, it should suit you just fine.

Moving up a step in Okidata's line, the

OkiPage 6ex offers an LCD readout, more expandability in terms of memory and input capacity than the 6e, and markedly better performance. In our labs, text was clean and images were acceptable; in general, output was virtually identical to that of the 6e. We did discover a bug when printing in 300 dpi. At this resolution, the printer can only generate bitmap soft fonts rather than TrueType fonts. Speed was better than the 6e, but not quite up to the 8-ppm competition. At this price, we prefer the Editors' Choice-winning NEC SuperScript 870 or the Minolta PageWorks 8L.

The more heavy-duty OkiPage 10i

offers a good balance of features, performance, and price and is worth considering. The generous 15,000-page-per-month duty cycle (second only to the Xerox DocuPrint P12 in this roundup) and optional paper trays (\$269 list for 500 sheets) and network connectivity (\$199 list for Ethernet) make it a good fit for small workgroups. The 10i was a piece of cake to set up and install. Its software driver presented some extra features, including thumbnails, watermarks, various half-tone settings, and toner-saving printing options.

In our labs, text was sharp and gray-scale graphics were well rendered, much

SUMMARY OF FEATURES

Laser Printers

■ YES ■ NO □ OPTIONAL

Products listed in review order

	Brother HL-1040	Brother HL-1050	HP LaserJet 1100	HP LaserJet 6P	Kyocera FS-600	Kyocera FS-800	Minolta PageWorks 8L	Minolta PageWorks 8e
Street price/Rated engine speed (ppm)	\$300 / 10	\$400 / 10	\$400 / 8	\$800 / 8	\$400 / 6	\$500 / 8	\$380 / 8	\$580 / 8
Resolution in draft mode/best mode (dpi)	300 / 600	600 / 1,200	600 / 600	600 / 600	600 / 1,200	600 / 1,200	600 / 600	600 / 600
Standard RAM/Maximum RAM	2MB / 2MB	4MB / 36MB	2MB / 18MB	2MB / 50MB	2MB / 34MB	4MB / 36MB	2MB / 18MB	2MB / 34MB
Engine type/manufacturer	Laser/Brother	Laser/Brother	Laser/Canon	Laser/Canon	Laser/Kyocera	Laser/Kyocera	Laser/Minolta	Laser/Minolta
Processor speed	16 MHz	66 MHz	35 MHz	24 MHz	50 MHz	50 MHz	20 MHz, 60 MHz	25 MHz
Dimensions (HWD, in inches)	9.7 x 14.6 x 15.5	9.7 x 14.6 x 15.5	14.9 x 14.5 x 12.8	7.9 x 15.6 x 17.5	8.7 x 14.3 x 14.2	8.7 x 14.3 x 14.2	11.4 x 15.5 x 9.7	17.5 x 15.5 x 21.8
Weight (pounds)	15.7	15.7	16.1	24.5	18.8	19.0	15.4	24.3
Input/output tray capacity (sheets)	200 / 100	200 / 100	125 / 100	250 / 100	150 / 150	150 / 150	150 / 100	650 / 100
Capacity of extra input tray (list price)	N/A	N/A	N/A	N/A	250 (\$179)	250 (\$179)	500 (\$159)	N/A
Can use trays from previous model	■	■	■	■	■	■	■	■
Heaviest paper (pounds)	42	42	43	43	54	54	90	90
Prints on legal-size paper/envelopes	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Prints on labels/index cards	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Parallel port/Serial port/USB	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
IEEE 1284 cable	Required	Required	Included	Required	Required	Required	Recommended	Recommended
Simultaneously supports active ports/InRA	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Price of internal network interface card	N/A	N/A	N/A	N/A	\$249	\$249	\$269	\$269
Natively supports DOS / Windows NT / OS/2	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Macintosh compatible	□	■	■	□	■	■	■	■
Highest PCL supported	PCL 5e	PCL 6	PCL 5e	PCL 6	PCL 5e	PCL 5e	PCL 4.5	PCL 6
PostScript/PrintGear support	■ ■	■ ■	■ ■	□ ■	■ ■	■ ■	■ ■	■ ■
Other emulations supported	Epson FX850, IBM ProPrinter XL	Epson FX850, IBM ProPrinter XL	None	None	Diablo 630, Epson LQ850 Line Printer, IBM ProPrinter X24E	Diablo 630, Epson LQ850 Line Printer, IBM ProPrinter X24E	HP LaserJet IIP	HP LaserJet 6P
Watermark/booklet printing	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Thumbnail (n-up) printing/Manual duplexing	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■	■ ■
Standard toner capacity, in pages (list price)	2,400 (\$33.99)	2,400 (\$33.99)	2,500 (\$50)	4,000 (\$80)	3,000 (\$51)	3,000 (\$51)	3,000 (\$73)	3,000 (\$73)
Rated cost per page, 5% coverage	1.4 cents	1.4 cents	2 cents	2 cents	1.7 cents	1.7 cents	2.4 cents	2.4 cents
Rated duty cycle (pages per month)	3,000	3,000	7,000	12,000	8,000	8,000	15,000	15,000
Toll-free technical support	■	■	■	■	■	■	■	■
Live technical support (eastern time)	9:00-7:30 M-F	9:00-7:30 M-F	8:00 A.M.-midnight M-F	8:00 A.M.-midnight M-F	8:00-6:00 M-F	8:00-6:00 M-F	24 hours, 7 days	24 hours, 7 days
Warranty	1 year	1 year	1 year	1 year	1 year	1 year	1 year	1 year
Overnight exchange under warranty	■	■	■	■	■	■	■	■

N/A—Not applicable; The product does not have this feature.

like the other two models reviewed here. Oddly, the 10i was unable to print our gray-scale TIF file properly in 600- by 1,200-dpi mode, failing to generate a number of multiline sections of text on each page and leaving gaps of white. The default 600-by-600 setting printed this file quite well. The 10i did fairly well in speed testing, keeping pace with the competition on longer documents, though a relatively long first-page-out penalized throughput on our shorter tests. Still, if you need a printer to share but can't justify the price of the Xerox P12 (\$700), the OkiPage 10i is worth a look.—MM

Xerox DocuPrint P8, DocuPrint P12

P8: 8 ppm; 600 x 1,800 dpi; \$300. **P12:** 12 ppm; 600 dpi; \$700. Rochester, NY; 800-832-6979; www.teamxrx.com; 528 at www.pcmag.com/infolink.

● Xerox offers two distinctly different monochrome lasers for this roundup. The DocuPrint P8 is aimed at buyers on a budget. It provides some interesting features and has the basics but lacks real muscle for demanding applications. The P12 is a network-capable solution, with the processing power and paper capacity to meet the needs of any business user and even small workgroups, at a price below that of HP's 8-ppm LaserJet 6P.

See www.pcmag.com for interactive views

PC MAGAZINE
EDITOR'S CHOICE

NEC SuperScript 870	OkiData OkiPage 6e	OkiData OkiPage 6ex	OkiData OkiPage 10i	Xerox DocuPrint P8	Xerox DocuPrint P12
\$350 / 8	\$250 / 6	\$350 / 6	\$500 / 10	\$300 / 8	\$700 / 12
800 / 600	600 / 1,200	600 / 1,200	600 / 1,200	800 / 1,200	800 / 600
2MB / 18MB	2MB / 19MB	2MB / 35MB	2MB / 35MB	6MB / 10MB	18MB / 10MB
Laser/Minolta	LED/OkiData	LED/OkiData	LED/OkiData	Laser/Xerox	Laser/Xerox
20 MHz, 80 MHz	25 MHz	25 MHz	28 MHz	N/A	60 MHz
15.5 x 11.5 x 10.5	6.9 x 12.6 x 14.2	6.9 x 12.6 x 14.2	7.9 x 13.0 x 14.8	12.0 x 15.4 x 12.5	18.8 x 16.6 x 9.0
17.6	17.0	17.0	22.0	10.6	27.1
150 / 100	100 / 100	100 / 100	250 / 150	250 / 150	250 / 40
500 (\$169)	250 (\$259)	250 (\$259)	100 (\$149), 500 (\$289)	N/A	500 (\$185)
43	32	32	32	50	34
Recommended	Required	Required	Not required	Included	Included
\$249	N/A	N/A	\$89	N/A	\$299
PCL 4.5	PCL 5e	PCL 5e	PCL 6	N/A	PCL 4.5
None	Epson FX, HiPer-W, IBM ProPrinter III XL	Epson FX, HiPer-W, IBM ProPrinter III XL	Epson FX, IBM ProPrinter III XL	None	None
3,000 (\$73)	2,000 (\$32)	2,000 (\$32)	2,000 (\$32)	3,000 (\$80)	6,000 (\$120)
1.8 cents	2.8 cents	2.8 cents	2.6 cents	2.7 cents	2 cents
8,000	8,000	8,000	15,000	3,000	20,000
8:30-8:00 M-F	24 hours, 7 days	24 hours, 7 days	24 hours, 7 days	8:00-8:00 M-F, 11:00-3:00 Sat.	8:00-8:00 M-F, 11:00-3:00 Sat.
2 years	1 year	1 year	1 year	3 years	3 years

The printers' setup routines are similar and straightforward: For each unit, install the toner cartridge, attach the supplied printer and power cables, load the paper, and install the drivers from floppy disks. The designers made some interesting decisions on the way to market with the P8. It offers 1,800- by 600-dpi image enhancement but only has 512K of RAM (more would be welcome). Although there's no option for a network adapter, the P8 comes with twin printer ports so you can connect two PCs at the same time. Drivers for Windows 3.x, 95, and NT 4.0 provide settings for *n*-up printing and for adjusting halftones for darkness and sharpness. Don't look for fancy LCD readouts, as there are just two basic LED status lights: a green power-on and an amber busy/alarm.

In our labs, the P8's text output was excellent, with solid black print and crisp type. Graphics quality was good; gradient fills were smooth, and large areas of black reproduced evenly. Intermediate grays reproduced acceptably, but highlights were slightly dull. On our speed tests, the P8 was an able performer, running right on track with other 8-ppm units. The Xerox DocuPrint P8 offers a rich feature set and good performance. It's well suited to individual general-purpose printing.

The P12 is a good low-cost workgroup machine with the features needed for light networking at a price competitive with some standalone lasers. Its optional 500-sheet tray (\$185 list), and generous 20,000-page-per-month duty cycle mean this machine is ready to grow with your business. Its image quality was excellent for both text and graphics, and type was sharp, with full, deep black-rendering. Test images printed with fine detail, pleasing middle tones, and very good conversion of colors to gray scales. Large solid areas were reproduced with no streaking or banding, and gradients were reproduced with smooth transitions. The P12's 12-ppm engine gave it a leg up on the competition on our multipage print jobs, but for short documents it trailed some of the 8- and 10-ppm machines in throughput.

The features and expandability of the DocuPrint P12 make it worth considering if you need a personal laser now that can become a networked laser down the road.—JK

MULTIFUNCTIONS

Brother MFC-P2000, MFC-4650, MFC-7150C

MFC-P2000: 10-ppm laser; 600 x 600; monochrome scanner/copier; \$400. **MFC-4650:** 6-ppm laser; 600 x 600; fax, monochrome scanner/copier; \$500. **MFC-7150C:** 6-ppm/4-ppm color ink jet; 1,440 x 720; fax, color scanner/copier; \$500. Bridgewater, NJ; 800-276-7746, 908-704-1700; www.brother.com; 529 at www.pcmag.com/infolink.



These three multifunction printers from Brother International Corp. have very distinct personalities: the do-everything, all-color, printer/fax/scanner/copier Brother MFC-7150C, our Editors' Choice; the plain-Jane monochrome printer/fax/scanner/copier MFC-4650; and the speedy, faxless, monochrome



printer/scanner/copier MFC-P2000.

Targeted at home and home-office users, the ink jet-based MFC-7150C is an excellent bundle for the price. It's a good

bet for people who want a business-quality machine that can also handle home tasks, such as color printing for kids. Print quality in our labs was acceptable in the default resolution, showing no problems with banding or uneven colors, though the unit's output was outclassed by that from the Canon multifunction ink jets. On our speed tests, this printer was fast for an ink jet, trading places for first with the HP OfficeJet Pro 1175C.

The built-in scanner (bundled with Visioneer's PaperPort and Xerox's TextBridge OCR) is quick as well, making this a fast copier: Black-and-white copies rolled out in less than 30 seconds, color copies in 77 seconds. Scan quality was reasonably good, with three resolution choices: 200 dpi, 300 dpi, and 200 by 400 dpi. Color options ranged from black-and-white to 24-bit color.

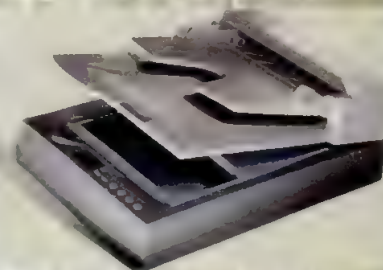
The MFC-7150C looks as familiar as any fax machine, down to the standard telephone handset on the left. (The MFC-4650 and MFC-7150C are also available in slightly upgraded versions with built-in answering machines that can organize incoming calls into separate mailboxes.) The buttons are plainly laid out and divided into functional units (fax keypad, 56-number speed-dial pad, and separate copy and print controls) so that you can get where you're going with-

out poring over the very thorough—and very long—manual. The machine will scan images to the fax queue immediately, even if it's printing at the same time and even if the machine doesn't get a dial tone right away.

If you ask for a copy during a print job, the machine will diligently scan your material, then print it out after the current job is finished. But during actual fax transmissions, even from memory, you're locked

Turning Your Printer Into a Copier

If you've ever wanted an inexpensive photocopier in your home or office, take a look at the Lumina PCC (\$250; Lumina Office Products, 408-487-0400, www.luminapcc.com; 534 at www.pcmag.com/infolink). A 30-bit flatbed scanner with a 100-sheet automatic document feeder on top, it uses your printer to make copies of text documents and color photos with your PC turned off, or not even attached.



Setup is simple: Just connect it to your printer, insert the original, and press "Copy" or "Color Copy." Your attached printer will spit out a duplicate. One caveat, though: Default mode is set for text, so for best color output you'll want to attach it to a PC and load the software driver.

But there are built-in limitations. The scanner has a native resolution of only 300 by 600 dpi. In our labs, this meant single-page color copies were somewhat blurry, even on high-quality photo paper printed on the excellent HP 2000C. And they took several minutes to produce.—Josh Levy

HOW WE RATED MULTIFUNCTION PRINTERS

	Price	Print quality	Scan quality	Fax functions	Overall speed	Vendor grade*
Brother MFC-P2000	\$400	Good	Fair	N/A	Excellent	C
Brother MFC-4650	\$500	Good	Good	Excellent	Fair	C
Brother MFC-7150C	\$500	Good	Good	Excellent	Good	C
Canon MultiPass C3500	\$330	Good	Fair	Good	Fair	B
Canon MultiPass C5500	\$450	Good	Excellent	Good	Fair	B
Canon MultiPass L6000	\$800	Excellent	Good	Good	Good	B
HP LaserJet 1100A	\$500	Excellent	Good	N/A	Good	A
HP LaserJet 3100se	\$700	Excellent	Excellent	Excellent	Excellent	A
HP OfficeJet 700	\$600	Excellent	Good	Good	Fair	A
HP OfficeJet Pro 1175C	\$1,000	Excellent	Excellent	N/A	Good	A
Okidata OkioOffice 44	\$500	Fair	Poor	Fair	Fair	C
Xerox WorkCentre 450c	\$300	Fair	Poor	Good	Poor	D

* Service and Reliability survey, PC Magazine, July 1998. N/A—Not applicable. This machine does not have fax capabilities. denotes Editors' Choice.



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Multifunction Printers

out of the scanner (which means no copies and no new fax) until completion, and the machine gives no indication of why you can't copy. We also found that during printing, the Twain driver became unavailable, preventing us from performing an ordinary scan until the print job was done.

It's a bit tricky loading the ink for this unit. To prevent wasting ink, there are separate cartridges for each color and a larger tank for black. They're hard to handle, however, because Brother's tanks are left permanently open after you peel off the tape, so drops can fall on you. Still, the MFC-7150C is an excellent multifunction printer that has everything you'll need for home and small-office work. The memory queue lets you use many of the features simultaneously, which is far from universal in these devices. It's a good choice for the price.

Like the MFC-7150C, the MFC-4650 can perform most of its various tasks simultaneously. The unit can even perform a standard document scan during a fax transmission, a task its color counterpart was unable to do in our labs. This is a fine choice for small businesses that print and scan lots of text.

During testing, we found the MFC-4650's output clear and sharp, with no major defects and good gray-scale rendering. It was slower than other laser-based multifunction devices on our printing tests, but not alarmingly so. It proved to be a speedy copier, however, pushing out its first sheet in 22 seconds. If you're in the market for a solid text printer that can also fax and scan business documents at a reasonable pace, the MFC-4650 is a fine value.

The MFC-P2000 strips off the fax capabilities of the MFC-4650 to create a monochrome-only combination printer, copier, and scanner. It's quick, stylish, and affordable. Essentially, you get a 600-dpi laser printer with a monochrome scanner on top. In our labs, the MFC-2000 produced images of about the same print quality as the MFC-4650's. The MFC-P2000 pulled far ahead on our speed tests, however: It's the fastest multifunction machine in this roundup.

The unit's controls are elegant in their simplicity, including a welcome Copy button that does what it says with one press. A Photo button improves the quality of copied photographs, although other machines

can do better without the need for such enhancement. Concurrency features fell short, too: The machine refused to accept presses of the Copy button while printing, and the Twain driver wouldn't even open the scanner's software interface while printing. In the tug-of-war with its main competitor—the HP LaserJet 1100A—we'd have to say this match is a tie. Either one will suit you if you want a laser printer with convenience copying and scanning to augment your fax machine.—Winn L. Rosch

Canon MultiPass C3500, C5500, L6000

C3500: 6.5-ppm/2.5-ppm color ink jet; 720 x 360; fax, monochrome scanner/copier; \$330. **C5500:** 6.5-ppm/2.5-ppm color ink jet; 720 x 360; fax, color scanner/copier; \$450. **L6000:** 6-ppm laser; 600 x 600 dpi; fax, monochrome scanner/copier; \$600. Costa Mesa, CA; 800-652-2666; www.ccsi.canon.com; 521 at www.pcmag.com/infolink.

● The three Canon MultiPass family members we tested are well-thought-out machines that will satisfy most users, though we preferred competing models

SUMMARY OF FEATURES

Multifunction Printers

PC MAGAZINE
BEST BUY
EDITOR'S CHOICE

■ YES ■ NO □ OPTIONAL

Products listed in review order

	Brother MFC-P2000	Brother MFC-4650	Brother MFC-7150C
Street price/Printing technology	\$400/Laser	\$500/Laser	\$500/Ink jet
Cost of replacement toner or ink	\$33.99	\$33.99	Black, \$11.99; color, \$8.99
Cost per page for monochrome print (5% coverage)	1.4 cents	1.5 cents	2.3 cents
Dimensions (HWD, in inches)	11.1 x 15.4 x 14.5	18.0 x 13.1 x 9.8	9.7 x 15.4 x 21.3
Weight (pounds)	18.7	15.8	20.0
Printing			
Rated engine speeds (monochrome/color, in ppm)	10 / N/A*	6 / N/A*	6 / 4
Maximum monochrome resolution (dpi)	600 x 600	600 x 600	1,440 x 720
Maximum color resolution (dpi)	N/A*	N/A*	1,440 x 720
Individually replaceable color cartridges	■	■	■
Low ink/toner warning	■	■	■
Stops printing if one color runs out	N/A*	■	■
Rated monthly duty cycle (pages)	3,000	230	830
Prints natively from operating systems other than Windows	■	■	■
Prints from a DOS box in Windows	■	■	■
Highest printer emulation supported	PCL 5	PCL 4	Epson LQ-510
Input/output tray capacities (sheets)	200 / 100	200 / 100	200 / 75
Transparency/envelope tray capacities	20 / 10	20 / 10	20 / 10
Faxing			
Modem speed (Kbps)	N/A*	14.4	14.4
Paper feed capacity/Memory capacity (pages)	N/A*	20 / 130	20 / 100
Telephone handset	N/A*	■	■
Telephone jacks/Speed-dial presets	N/A*	1 / 100	1 / 56
Fax software supplied	N/A*	MFL Pro	MFL Pro

Scanning

Monochrome or color scanning (bit depth)	Monochrome (8-bit)	Monochrome (8-bit)	Color (24-bit)
Highest optical scanning resolution (dpi)	200	200	300
OCR software included	TextBridge Classic	TextBridge Classic	TextBridge Classic
Document management software included	Visioneer	Visioneer	Visioneer

Copying

Rated engine speed (monochrome, in ppm)	10	6	3
Maximum number of copies/Resolution (dpi)	99 / 300	99 / 400	99 / 720
Reducing/enlarging (% of original)	50 / 200	50 / 200	50 / 200
Live technical support (eastern time)	8:00-7:30 M-F	8:00-7:30 M-F	8:00-7:30 M-F

Warranty (parts and labor)

Overnight exchange under warranty

N/A*—Not applicable: The product does not have this feature.

N/A*—Not applicable: The printer uses manual feed for these media.

such as the Brother MFC-7150C and HP LaserJet 1100A.

A common software interface and identical control panels unify the MultiPass family. Everyday operation is simple: You'll find a telephone keypad on the left, a cluster of six essential control buttons (such as Start and Stop) in the center, and maintenance buttons—plus six speed-dial buttons—on the right. The control system, which gives you more options than you may even want to deal with, is com-

prehensive but cumbersome. Each of these units also multitasks well, accepting pages into memory while printing or even while dialing and sending your fax.

One irritant we encountered with all three printers was the impossibility of making a single copy with just one press of a button, because you first have to set modes, quality levels, and media types. It would be gratifying to have a single Copy button.

The Canon MultiPass C3500 is a reasonably full-featured choice for budget-

minded home or small-office users. But though the unit provides the range of functionality many users will want, it's a bit too expensive given its unimpressive speed and lack of color scanning. In our labs, image quality on the C3500's printouts was good. There were some very minor artifacts and banding on large areas of continuous tone, but prints were attractive—better than those from the Brother MFC-7150, though not as good as those from the HP Office-Jets. On our speed tests, the C3500 proved

See www.pcmag.com for interactive views

Canon MultiPass C3500	Canon MultiPass C5500	Canon MultiPass L6500	HP LaserJet 1100A	HP LaserJet 3100se	HP OfficeJet 700	HP OfficeJet Pro 1175C	Okidata Okioffice 44	Xerox Document WorkCentre 450c
\$330/Ink jet \$50.00	\$450/Ink jet \$50.00	\$600/Laser \$93.00	\$500/Laser \$50.00	\$700/Laser \$70.00	\$600/Ink jet Black, \$35.99; color, \$36.99	\$1,000/Ink jet Black, \$35.99; color, \$39.99	\$500/LED \$28.50	\$300/Ink jet Black, \$39.99; color, \$9.99
4 cents	4 cents	4 cents	2 cents	2.4 cents	4 cents	3 cents	4 cents	4 cents
7.8 x 15.8 x 14.2	7.8 x 15.8 x 14.2	9.5 x 14.4 x 14.4	14.9 x 14.5 x 15.8	10.8 x 15.1 x 16.4	10.8 x 17.5 x 14.6	12.8 x 21.3 x 17.7	7.5 x 12.3 x 15.3	12.0 x 16.5 x 17.5
13.2	13.2	19.0	19.2	22.0	15.0	32.2	16.8	18.5
6.5 / 2.5	6.5 / 2.5	6 / N/A*	8 / N/A*	6 / N/A*	5 / 2	9 / 6	4 / N/A*	4 / 1.7
720 x 360	720 x 360	600 x 600	600 x 600	600 x 600	600 x 600	600 x 600	600 x 600	600 x 600
720 x 360	720 x 360	N/A*	N/A*	N/A*	600 x 300	600 x 600	N/A*	300 x 300
■	■	■	■	■	■	■	■	■
■	■	■	■	■	■	■	■	■
Info not available	Info not available	Info not available	7,000	6,000	830	3,000	500	Info not available
■	■	■	■	■	■	■	■	■
Canon Extended Mode	N/A*	N/A*	PCL 5e	PCL 4	PCL 3	PCL 3	N/A*	PCL 3C
100 / 100	100 / 100	100 / 100	125 / 100	100 / 100	150 / 50	150 / 50	100 / 30	150 / 20
50 / 15	50 / 15	15 / 7	10 / 10	75 / 10	50 / 10	100 / 15	N/A**	10 / 10
14.4	14.4	14.4	N/A*	14.4	14.4	N/A*	14.4	14.4
30 / 42	30 / 42	20 / 122	N/A*	30 / 150	20 / 85	N/A*	20 / 20	23 / Info not available
■	■	■	■	■	■	■	□	■
2 / 56	2 / 56	2 / 56	N/A*	1 / 175	1 / 50	N/A*	2 / 55	2 / 84
Adobe PhotoDeluxe Business Edition, Desk Top Manager	Desk Top Manager	Desk Top Manager	N/A*	JetSuite Pro for HP	HP OfficeJet Manager	WinFax Pro	JetSuite	WinFax Lite
Monochrome (8-bit) 400	Color (24-bit) 300	Monochrome (8-bit) 300	Monochrome (8-bit) 300	Monochrome (8-bit) 300	Color (24-bit) 330	Color (30-bit) 330	Monochrome (8-bit) 200	Monochrome (8-bit) 300
TextBridge Pro	TextBridge Pro	TextBridge Classic	ReadIris Pro OCR	ReadIris Pro OCR	Caere OmniPage LE	Caere OmniPage LE	Caere WordScan	TextBridge Pro
Desk Top Manager	Desk Top Manager	Desk Top Manager	HP LaserJet Document Desktop	JetSuite Pro for HP	None	None	JetSuite	Pagis Pro
3	3	6	8	6	5	9	4	3
99 / 360	99 / 360	99 / 600	99 / 300	99 / 300	99 / 300	50 / 600	50 / 300	99 / 300
N/A***	N/A***	N/A***	25 / 400	50 / 200	25 / 400	25 / 400	25 / 200	75 / 150
24 hours, 7 days	24 hours, 7 days	24 hours, 7 days	8:00-midnight M-F	8:00-midnight M-F	8:00 A.M.-10:00 P.M. M-F, 9:00-4:00 Sat.	8:00 A.M.-10:00 P.M. M-F, 9:00-4:00 Sat.	24 hours, 7 days	8:00-8:00 M-F, 11:00-3:00 Sat.
1 year	1 year	1 year	1 year	1 year	1 year	1 year	1 year	1 year
■	■	■	■	■	■	■	■	■

N/A***—Not applicable. Reducing and enlarging are available only through software.

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Compare the Output: *Multifunction Printers*

The multifunction market is split about evenly between monochrome laser- and color ink jet-based engines. Here we show text output (enlarged five times) from the 12 machines we tested. Ideally, an ink jet's text will be nearly as crisp as a laser's.

Brother MFC-P2000
\$400 laser

Dear

Brother MFC-4650
\$500 laser

Dear

Brother MFC-7150C
\$500 ink jet

Dear

Canon MultiPass C3500
\$330 ink jet

Dear

Canon MultiPass C5500
\$450 ink jet

Dear

Canon MultiPass L6000
\$600 laser

Dear

HP LaserJet 1100A
\$500 laser

Dear

HP LaserJet 3100se
\$700 laser

Dear

HP OfficeJet T00
\$600 ink jet

Dear

HP OfficeJet Pro 1175C
\$1,000 ink jet

Dear

Okidata OkiOffice 44
\$500 LED

Dear

Xerox WorkCentre 450c
\$300 ink jet

Dear

about average for an ink jet. Photocopies, available in monochrome only, took a sluggish 54 seconds each.

Canon's built-in 8-bit gray-scale scanner produced acceptable but somewhat fuzzy scans. On balance, this is a competent but somewhat underpowered machine that ought to be about \$100 cheaper.

If you're tempted by the C3500 but you need a full-fledged color page scanner, the Canon MultiPass C5500 is a fine choice. It delivers the same quality and features as the C3500, but adds a very good color scanner. The only drawback is speed; Brother's MFC-7150C is faster, and costs only \$50 more. Output quality was good, a bit better than that from the C3500, with no obvious banding problems. On our speed tests, the C5500 performed about average for an ink jet, posting almost exactly the same speeds as its sibling. As with the C3500, the copy function took some time: A black-and-white copy required 53 seconds to roll out; top-quality color copies needed about 5 and a half minutes. In addition, we encountered some problems with pages stored in memory: The C5500 stalled with just over 6 pages in the queue, though it's rated for 40.

The C5500's color scanner is one of the

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microLaser 200

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Paper Input: 900 std., up to 1,400 opt.
Duty Cycle: 50,000 pages per month
Std. Interfaces: Ethernet, parallel, SCSI
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*Source: February 1998 US Q-Stats, Gartner Group/Dataquest, 400CPS+ printers

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best of any bundled with a multifunction machine today, offering 24-bit true color depth, and resolution of up to 300 dpi (600 dpi enhanced). You can also set it to scan lesser resolutions with its Twain-based ScanGear software. Scanned copies were very good, with perfect flesh tones and no banding in color.

The full-featured C5500 is a good buy for home and small-office users. It isn't the fastest machine on the market (the Brother MFC-7150C is much quicker),



but its scan quality makes it stand out from the competition.

The SOHO-oriented Canon MultiPass L6000 is a laser-based monochrome multifunction unit. Text output was very fine and crisp, and halftone rendering was sharp despite some unevenness in large areas of continuous tone. On our speed tests, its performance was respectable—average among the laser machines. Copying was very fast, pumping out pages in only 17 seconds.

The 300-dpi monochrome scan quality was good, with especially good reproduction of photos. We had some of the same memory storage problems we did with the C5500; the L6000's queue accepted only ten dense pages of text before clogging. But this printer provides what its intended customers will expect: good text quality, reasonable speed, and eminently respectable monochrome copies and scans.

Compared with other personal multifunction printers, the MultiPass trio wins high marks for image quality and acceptable if not class-leading speed. But before committing, be sure to compare each unit against its counterparts from Brother and HP.—WLR

HP LaserJet 1100A, LaserJet 3100se, OfficeJet 700, OfficeJet Pro 1175C

LaserJet 1100A: 8-ppm monochrome laser; 600 dpi; monochrome scanner/copier; \$500 street. **LaserJet 3100se:** 6-ppm monochrome laser; 600 dpi; fax, monochrome scanner/copier; \$700. **OfficeJet 700:** 5-ppm monochrome/2-ppm color ink jet; 600 dpi; fax, color scanner/copier; \$600. **OfficeJet Pro 1175C:** 9-ppm monochrome/6-ppm color ink jet; 600 dpi; color scanner/copier; \$1,000. Palo Alto, CA; 800-752-0900; www.hp.com; 524 at www.pcmag.com/infolink.

● Hewlett-Packard's All-in-One family (the company eschews the term *multifunction*) is one of the most extensive lines of multifunction devices on the market. The four we tested demonstrate HP's expertise at combining speed, functionality, and ease of use, all at a competitive price.

The LaserJet 1100A consists of a snap-on scanning/copying module attached to a standard LaserJet 1100 printer (reviewed in this story's Laser section). If you don't need fax capability, the 1100A provides great output quality, su-

perior performance, and good functionality at a low price. On our tests, the 1100A produced sumptuous output that was virtually free from streaking and artifacts. Unlike other multifunction machines we tested, its 300-dpi 8-bit scanner generated usable gray-scale output with an extended dynamic range, relatively smooth shading, and acceptable contrast. Our speed tests showed the 1100A to be one of the fastest multifunction devices in the roundup for text documents, pumping out our 12-page text document at almost its rated 8-ppm engine speed. It slowed considerably, however, on the graphics-intensive files of our Microsoft PowerPoint and Microsoft Publisher tests.

The 1100A's elegant front panel contains just a handful of buttons that perform basic scanning and copying tasks. Additional operations can be managed easily through HP's Document Assistant application toolbar, which pops up when you insert a sheet of paper into the 1100A's input tray. Document Assistant provides a solid selection of basic scanning, copying, OCR, and printing functions, and even lets

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SERIES

Multifunction Printers

you route scans directly to third-party fax modem software. The 1100A is a terrific buy for the home or office that doesn't need another fax machine.

The LaserJet 3100se is a more traditional multifunction that delivers comprehensive fax functionality and robust multitasking capabilities and is a good choice for busier office environments. The 3100se's large, well-organized control panel provides easy access to the machine's array of automated dialing features, image-quality settings, interactive menu system, and copying and fax functions. You can access a huge selection of advanced fax functions from either the menu system or from the 3100se's JetSuite fax/print/scan/copy software. The machine also provides luxuries such as remote diagnostics, a fax plug-in module for Microsoft Excel and Word, and customizable sound capabilities. (You can program the software to play predetermined WAV files when certain events take place, such as an incoming fax.)

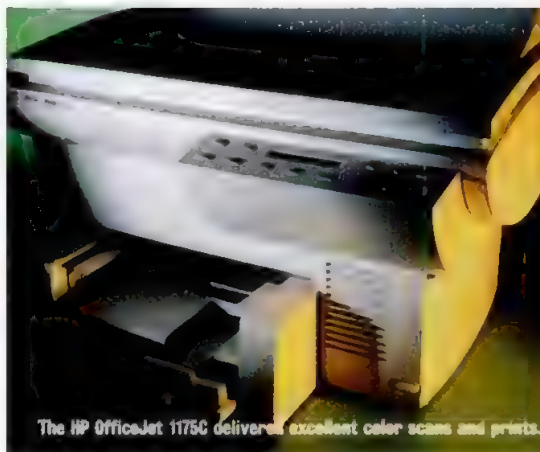
Although slightly more prone to streaking than the 1100A, the 3100se's laser output is easily the equal of most mid-priced standalone lasers. Its 300-dpi gray-scale scanner produced satisfactory output. Speed was mid-pack among lasers.

The OfficeJet 700 is a spiffy ink jet model aimed at home offices and mid-sized businesses. It's built for ease of use, has a respectable feature set, and generates attractive color output. Its 24-bit, 300-dpi engine produces output on a par with that of many consumer flatbed scanners, and its driver offers user-friendly features like automatic straightening and cropping, and the ability to scan text directly into AOL- or MAPI-compatible e-mail systems. The 700 also offers faxing and color copying capabilities.

When equipped with HP's optional PhotoCartridge (\$39.95 list), the OfficeJet 700 produces beautiful color output—on a par with the best standalone ink jet printers. On our speed tests (using the standard cartridge), the 700 was a bit slower than average for an ink jet unit, though not alarmingly so. Our only complaints are the 700's inability to perform multiple functions simultaneously and a slight problem with dithering artifacts. But these seem trivial compared with the machine's superior usability and functionality.

The OfficeJet Pro 1175C is a higher-

end ink jet designed for more demanding business applications. It's a massive unit with a flatbed-style copy/scan mechanism and a print engine that's faster than many standalone ink jets on the market. Like



the OfficeJet 720, the 1175C offers high-quality color scanning, copying, and printing capabilities. It lacks a fax module but does offer a Scan-to-Fax function that lets you transmit scanned documents directly to a PC-attached fax modem.

Despite an exhaustive array of copy-

ing, scanning, and printing options, the 1175C is easy to use, thanks to a nicely laid-out front panel and well-designed driver software. In most cases, merely specifying the type of output medium automatically adjusts all the other settings.

The 1175C's output quality is stunning, with rich color, subtle shading, superior detail and virtually no sign of artifacts. Photocopies did suffer a bit from streaking in large black areas, and scanned images tended to be too dark, but both of these problems were relatively minor. On our speed tests, the 1175C was among the fastest of the ink jet multifunctions, beating the Brother MFC-7150 on some

tests and trailing it in others.

The bottom line is that the OfficeJet Pro 1175C excels in ease of use, output quality, speed, and functionality. The unit may be one of the most expensive multifunction printers on the market, but it's worth every penny.—Don Labriola

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Okidata OkiOffice 44

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● It's hard to get excited about the Okidata OkiOffice 44. Despite a superior feature set and competitive price, the poor output quality and barely usable scanner module limit it to environments with only modest fax, copier, and printing requirements.

Casual users will be baffled by the complicated front panel, which has more than 30 buttons—many of which serve multiple purposes—and which is hampered by a complex LCD menu system. The OkiOffice also lacks multitasking capabilities, so it can't copy, scan, fax, or print while any other function is in progress.

In the OkiOffice's favor, its fax module boasts an array of routing, formatting, and reporting features, and its copier functions include flexible scaling options and the ability to print two or four pages on one sheet. Neither the fax nor the copier could reproduce photographs very well, but both were adequate for text documents. Indeed, the weakest element is the 200- by 400-dpi scanner. Using it with photographs produced unrecognizable results, although we did have success scanning text into the bundled Caere's WordScan Plus OCR.

The OkiOffice's LED print engine is designed to deliver output quality comparable to that of a 600-dpi laser printer. Text output was crisp, but graphics were marred by streaking and compressed midrange and shadow details. Not surprising, the unit's 4-ppm engine couldn't keep pace with the other laser-class machines (rated at 6 ppm and above) on our tests.

The OkiOffice 44 is a mass of compromises that could never replace a stand-alone fax, copier, or scanner. It'll do the job if you work primarily with text, but anyone who wants a more flexible solution would be better off with the similarly priced laser-based units from Brother or HP.—DL

Xerox Document WorkCentre 450c

7-ppm monochrome/1-ppm color ink jet, 600 dpi; fax, monochrome scanner/copier; \$300. Rochester, NY; 800-275-9376; www.teamxrx.com; 528 at www.pcmag.com/infolink.

● The Xerox Document WorkCentre 450c is the least expensive multifunction printer we tested, and it could have been a contender. But its strengths—ease of use and

low price—are undercut by sluggish speed, rudimentary scanning, and poor image quality. This is especially disappointing given all the things Xerox did right. The 450c has comprehensive multitasking capabilities and a superior set of advanced fax



features. The comprehensive feature set is easy to access via the intelligently laid-out front panel. Installation and maintenance are hassle-free, and it's easy to configure the printer for different types of print jobs and paper.

But the 450c fails when it comes to output quality. Xerox's first mistake was marrying a color print engine to an 8-bit monochrome scanner module. For scanning and copying, the 8-bit monochrome scanning module generates output that isn't much better than a fax's. Color printouts are not up to the good-to-great output of current-generation ink jets; we saw obvious banding, streaking, and dithering patterns. Worse yet, the printer isn't always clever enough to print monochrome images with black ink automatically and often produces output with a distinctly violet cast. On our speed tests, the 450c trailed the other ink jet multifunctions on nearly every test.

If you're looking for a no-frills multifunction machine that costs less than the competition, the Xerox Document WorkCentre 450c could conceivably be a cost-effective choice. But we recommend you spend the extra money for the Brother, Canon, or HP color units.—DL

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Therefore, we sell our printers direct, eliminating many prosperous middlemen, and lowering your costs.

We also provide direct technical support, eliminating other middlemen who can't solve your problems. And we are compassionate hand-holders. We offer unlimited free technical support, not just on business days, but on Saturdays too – throughout the one-year warranty period. And if during that period you have a problem that our technical support people can't solve, our Platinum Exchange program guarantees you a replacement printer by the next business day.

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Maximum Print Area 8.5" x 14"
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PostScript® Level 2 compatible, PCL 5
80 PostScript fonts, 15 PCL fonts
RAM expandable to 64 MB
EtherTalk®, LocalTalk®, TCP/IP
Ethernet (10BaseT), Bi-directional Parallel

2nd Paper Feeder*
(Includes 500 sheet Universal Tray) Add \$299

Extra 8 MB Memory Add \$ 49

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Platinum Exchange Warranty Program
Additional Year Add \$ 119



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20 pages per minute
1 year Platinum Exchange Warranty
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500 sheet Universal Tray
PostScript® Level 2 compatible, PCL 5
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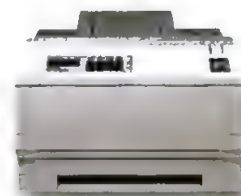
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Platinum Exchange Warranty Program
Additional Year Add \$ 199

\$2199 **1200 dpi**

Business Lease \$75 Month/36 months

Platinum Exchange Warranty Program
Additional Year Add \$ 219



ELITE XL 8 Series

8 pages per minute
1 year Platinum Exchange Warranty
Maximum Print Area 11" x 17"
Ledger, letter, legal, A3, A4, envelope
250 sheet Universal Tray
PostScript® Level 2 compatible, PCL 5
80 PostScript fonts, 15 PCL fonts
RAM expandable to 64 MB
EtherTalk®, LocalTalk®, TCP/IP
Ethernet (10BaseT, 10Base2), Parallel

2nd Paper Feeder*
(Includes 250 sheet Universal Tray) Add \$319
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Extra 8 MB Memory Add \$ 49

\$1399 **600 dpi**

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Platinum Exchange Warranty Program
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* The Elite 12/600, Elite 1212, and the Elite XL 608LC support one additional paper feeder. The Elite XL 20/600, Elite XL 20/800, and the Elite XL 20/1200 support two additional trays.

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PERFORMANCE TESTS

Multifunction Printers



Among ink jet MFPs, the Brother MFC-7150 and HP OfficeJet Pro 1175C boasted the best print engine speed. The Brother MFC-P2000 was much faster than the other laser-based multifunction machines.

The multifunction printers in this roundup are designed to perform various tasks other than printing, such as copying, faxing, and scanning. Although we reviewed these functions qualitatively, we measured print speeds quantitatively, with the same rigor as in our reviews of standard printers submitted for this roundup.

At just under 5 ppm, the HP OfficeJet Pro 1175C was unrivaled among ink jet-based MFPs on the 12-page Microsoft Word Text test. On the same test, the Brother MFC-7150C was almost 2 ppm slower, despite having the second-fastest print engine among the ink jets. On all other tests, however, the Brother printer was ahead of the OfficeJet Pro, usually by at least a page per minute. As for the Canon MultiPass C3500 and MultiPass C5500, they delivered virtually identical sluggish speeds throughout all the tests (they're based on the same BubbleJet engine).

The laser-based Brother MFC-P2000 showed unrivaled print speeds in our labs, nearly matching the Brother HL-1040, which topped the laser printer category. Both units demonstrated speeds of nearly 10 effective ppm, with only a slight slowdown for graphics-heavy jobs. By contrast, the HP LaserJet 1100A peaked at just under 8 ppm when printing a pure text document and was about 60 percent as fast when graphical elements were added to the job. As expected, the 4-ppm-rated, LED-based Okidata OkiOffice 44 was the slowest on almost every test; the exception was the 6-page Microsoft PowerPoint test, on which the HP LaserJet 1100A and Canon MultiPass L6000 were slower.—*Analysis written by S. Jae Yang*

How We Tested

For each printer, we asked the vendors to recommend the driver and resolution setting that typical users are expected to use. We measured the "click-to-clunk" time, which we defined as the interval from the moment you click the OK button in the print dialog box to the moment the last page is released to the output tray, using Genoa Technology's automated printer-performance system (described in the ink jet Performance Tests section). In the table, we present the data in "effective pages per minute," which is calculated based on the click-to-clunk time, which includes the first-page-out delay at the beginning of each print job.

The **Microsoft Word Text** and **Graphics** tests measure the print-

er's speed in using Word 97 to print a 1-page letter with a graphic letterhead and a 12-page document with heavily formatted text and graphics. The graphics consist of two half-page bitmapped images: one a photograph, the other an image with a large amount of black.

The **Microsoft Word Text** tests measure the printer's speed in using Word 97 to print a 1-page text document consisting of monochrome text and a 12-page all-text document containing Arial, Times New Roman, and Courier True Type 12-point fonts, unstyled.

For the **Microsoft Excel** test, we printed a two-page Excel 97 spreadsheet with tables and various types of graphs.

The one-page **Microsoft Publisher** newsletter document contains various typefaces and font sizes as well as photographic images.

For the **Microsoft PowerPoint** test we printed six typical presentation slides from PowerPoint 97 on both plain paper and transparencies. The slides contained a demanding mix of text, graphics, and complex background patterns. **PC**

MULTIFUNCTION PRINTERS

High scores are best. Bold type denotes first place.

Effective ppm. High scores are best. **PC** denotes Editors' Choice. Microsoft Excel 2 pages. Microsoft Publisher 1 page. Microsoft PowerPoint 6 pages.

INK JET			
Brother MFC-7150C	2.62	1.82	1.40
Canon MultiPass C3500	0.66	0.50	0.28
Canon MultiPass C5500	0.66	0.50	0.27
HP OfficeJet 700	0.54	0.41	0.29
HP OfficeJet Pro 1175C	0.74	0.48	0.45
Xerox WorkCentre 450e	0.55	0.39	0.21

LASER

Brother MFC-P2000	5.98	3.56	7.94
Brother MFC-4650	3.78	1.87	3.83
Canon MultiPass L6000	3.11	1.73	2.56
HP LaserJet 1100A	4.80	1.43	0.99
HP LaserJet 3100se	3.60	1.98	3.26
Okidata OkiOffice 44	2.73	1.48	3.19

▼ Among ink jet-based machines, the HP OfficeJet Pro 1175C was the quickest in spitting out the 1-page text job, but it slowed when handling graph-

ics. At a measured 4 ppm on the Microsoft Word Text test, the Brother MFC-P2000 outpaced all other laser MFPs by a wide margin.

MULTIFUNCTION PRINTERS

High scores are best. Bold type denotes first place.

Effective ppm. **PC** denotes Editors' Choice. Microsoft Word Text and Graphics 1 page. Microsoft Word Text 1 page. Microsoft Word Text 12 pages.

INK JET			
Brother MFC-7150C	2.67	2.78	2.75
Canon MultiPass C3500	0.96	1.06	1.53
Canon MultiPass C5500	0.97	1.09	1.48
HP OfficeJet 700	0.96	0.96	2.06
HP OfficeJet Pro 1175C	1.46	1.44	3.46
Xerox WorkCentre 450e	0.72	0.67	0.89
LASER			
Brother MFC-P2000	4.23	9.42	4.04
Brother MFC-4650	2.52	4.80	1.98
Canon MultiPass L6000	2.79	5.46	2.71
HP LaserJet 1100A	2.76	4.00	3.37
HP LaserJet 3100se	2.71	4.96	2.60
Okidata OkiOffice 44	1.93	3.60	1.91

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Armada 1700 \$1,999⁴
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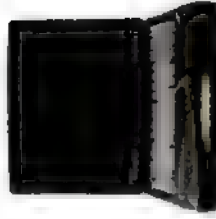
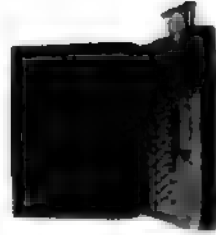
- Mobile Pentium II Processor up to 300MHz and up to 160MB of memory for demanding applications

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(model 1573 on last page)





	Armada 1592DMT	Armada 1700	Armada 1700	New Armada 1700
Pentium Processor	233MHz w/MMX	Mobile Pentium II 233MHz	Mobile Pentium II 233MHz	Mobile Pentium II 300MHz
Std./Max. Memory	32MB/96MB	32MB/160MB	32MB/160MB	32MB/160MB
SMART Hard Drive†	3.2GB	3.2GB	4GB	5GB
L2 Cache	512KB	512KB	512KB	512KB
Communications	56K ³	56K ³	56K ³	56K ³
Diskette Drive	3.5" 1.44MB (dual-bay)	3.5" 1.44MB (multi-bay)	3.5" 1.44MB (multi-bay)	3.5" 1.44MB (multi-bay)
CD-ROM	20X ¹ Max	24X ² Max	24X ² Max	24X ² Max
Display	12.1" TFT SVGA	12.1" CSTN SVGA	12.1" TFT SVGA	14.1" TFT (1024 x 768)
Video Support (All Models)	64-bit Local Bus Graphics with 2MB EDO Video RAM			
PC Card Slots	2 Type II or 1 Type III	2 Type II or 1 Type III	2 Type II or 1 Type III	2 Type II or 1 Type III
Compaq PremierSound®	Standard	Standard	Standard	Standard
IR	4Mbps Compliant	4Mbps Compliant	4Mbps Compliant	4Mbps Compliant
Battery Type/Life (All Models)	Dual Li-Ion Battery Support, up to 2-3 Hours per Battery*			
Pointing Device	Touchpad	Touchpad	Touchpad	Touchpad
Ports (All Models)	Serial, Enhanced Parallel, Keyboard/Pointing Device, Ext. Monitor, Fast IR, Audio In, Headphone Out, Mic, AC and Convenience Base RJ-11, USB			
Intelligent Manageability	Standard	Standard	Standard	Standard
Preinstalled Operating System*	Windows® 95	Windows 95	Windows 95, Windows 98, or Windows NT® 4.0**	Windows 95, Windows 98, or Windows NT 4.0**
Dimensions/Weight (lbs.)	2.1" x 12.2" x 9.6"/7.49	2.3" x 12.5" x 9.9"/7.8	2.3" x 12.5" x 9.9"/8.3	2.3" x 12.5" x 9.9"/8.3
Worldwide Limited Warranty*	1-Year, upgradeable	1-Year, upgradeable	1-Year, upgradeable	1-Year, upgradeable
New Low Prices	\$1,999	\$2,499	\$2,999	\$3,799
Lease Price	\$67/mo.	\$84/mo.	\$101/mo.	\$128/mo.

*Other operating systems available
 **Ask your operator for Windows NT 4.0 prices
 †For hard drives, GB=billion bytes.

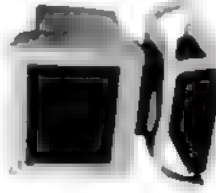
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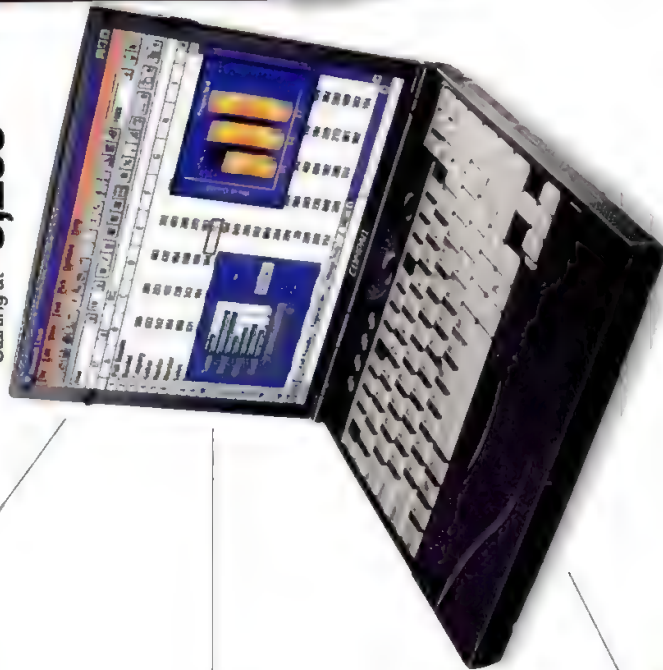
Armada 3500 & 6500

These new, lightweight notebooks are perfect for executives and sales professionals.

The Compaq Armada 3500 delivers power with state-of-the-art technology — yet weighs less than five pounds. The optional Mobile Expansion Unit creates a fuller function notebook when necessary. For high performance and an extra-generous display in a lightweight portable, choose the Compaq Armada 6500.

- Mobile Pentium II Processor 266 or 300MHz, up to 192MB memory, and 4.1 or 6.4GB¹ Hard Drive

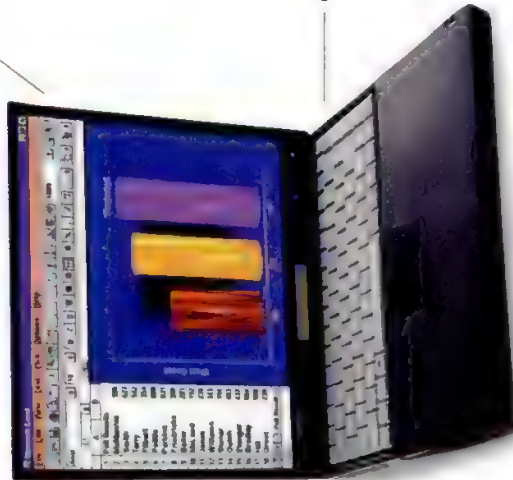
Armada 3500 \$3,299⁴
Starting at



- Up to 13.3" CRT screen at 1024 x 768 resolution and 24X² Max CD-ROM or DVD in optional Mobile Expansion Unit

- At a mere 4.4 pounds, Compaq's thinnest, lightest notebook also offers cutting-edge technology

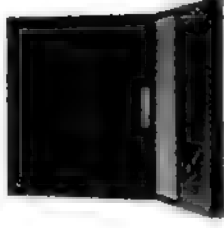
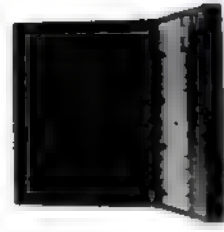
- Mobile Pentium II Processor 300MHz, up to 320MB of memory, and 6.4GB Hard Drive



- 14.1" CRT screen at 1024 x 768 resolution, and slim 5.9-lb. form factor

- Integrated communications: 56K³ modem and integrated 10/100 Ethernet controller; over 3 hours of battery life⁵ with 12-cell Li-Ion battery

Armada 6500 \$4,999⁴
Starting at



	Armada 3500	Armada 3500	Armada 6500
Pentium II Processor	266MHz	300MHz	300MHz
L2 Cache	512KB	512KB	512KB
Std./Max. Memory (SDRAM)	32MB/160MB	64MB/192MB	64MB/320MB
Hard Drive	4.1GB (SMART)	6.4GB (SMART)	6.4GB
Display	12.1" TFT SVGA	13.3" TFT (1024 x 768)	14.1" TFT (1024 x 768)
Video Support	64-bit Graphics	64-bit Graphics	2X AGP w/4MB SGRAM
Diskette Drive	1.44MB External, standard	1.44MB External, standard	1.44MB Module included
CO-ROM	Optional Mobile Expansion Unit	Optional Mobile Expansion Unit	24X* Max
Integrated Communications	Optional PC Card	Optional PC Card	56K*
Network Controller	N/A	N/A	Integrated 10/100 Ethernet
PC Card Slots	2 Type II or 1 Type III	2 Type II or 1 Type III	2 Type II or 1 Type III
Compaq PremierSound	Included	Included	Included
Battery Type/Life	Li-Ion/2-3 hours*	Li-Ion/2-3 hours*	12-cell Li-Ion/over 3 hours*
Pointing Device	EasyPoint™ pointing stick	EasyPoint pointing stick	Touch Pad
Ports	Serial, Enhanced Parallel, PS/2 Keyboard/Mouse, USB, Headphone/Speaker, VGA (External FDD: 3500 only; Mic Input: 6500 only)	Serial, Enhanced Parallel, PS/2 Keyboard/Mouse, USB, Headphone/Speaker, VGA (External FDD: 3500 only; Mic Input: 6500 only)	N/A*
Intelligent Manageability	Yes	Yes	N/A*
Dimensions/Weight	13" x 9.2" x 11.8"/4.4 lbs.	13" x 9.2" x 11.8"/4.6 lbs.	13.6" x 9.7" x 12"/5.9 lbs.
Preinstalled Operating System**	Windows 95 or Windows 98	Windows 95 or Windows NT 4.0†	Windows 95, Windows 98 or Windows NT 4.0†
Worldwide Limited Warranty*	3-Year	3-Year	3-Year

New Low Prices	\$3,299	\$4,299	\$4,999
Lease Price**	\$111/mo.	\$145/mo.	\$168/mo.

*DMM 2.0 compatibility information will be available soon on Compaq's website
 **Other operating systems available
 †Ask your operator for Windows NT 4.0 prices
 *For hard drives, GB=billion bytes

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256MB memory, and up
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Armada 7400 \$3,299⁴
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- 13.3" CTFI screen, AGP
graphics, and 24X Max
CD-ROM

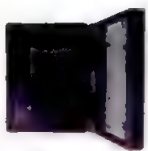


- 13.3" or 14.1" CTFI screen
at 1024 x 768 resolution and
24X Max CD-ROM or DVD

- AGP graphics with
3D acceleration support

Armada 7800 \$4,399⁴
Starting at

- Combines lightweight,
compact, and durable design
with leading-edge technology



	Armada 7400	Armada 7400	Armada 7800	Armada 7800	Armada 7800
Pentium II Processor	266MHz	300MHz	266MHz	266MHz	300MHz
L2 Cache	512KB	512KB	512KB	512KB	512KB
Std./Max. Memory	32MB/256MB	64MB/256MB	64MB/256MB	64MB/256MB	64MB/256MB
SMART Hard Drive	4GB	6.4GB	5GB	8GB	8GB
Display	13.3" TFT (1024 x 768)	13.3" TFT (1024 x 768)	13.3" TFT (1024 x 768)	14.1" TFT (1024 x 768)	14.1" TFT (1024 x 768)
Video Support	AGP	AGP	AGP	AGP	AGP
Multibay Diskette Drive			Removable 3-mode 1.44MB		
CD-ROM/DVD	Multibay 24X Max	Multibay 24X Max	Multibay 24X Max	Multibay 24X Max	Multibay DVD
Integrated Communications	N/A	33.6Kbps*	33.6Kbps*	33.6Kbps*	33.6Kbps*
PC Card Slots	2 Type II or 1 Type III	2 Type II or 1 Type III	2 Type II or 1 Type III	2 Type II or 1 Type III	2 Type II or 1 Type III
Compaq PremierSound	Included	Included	Included	Included	Included
Battery Type/Life	LI-Ion/Up to 2.6 hours ⁴	LI-Ion/Up to 2.6 hours ⁴	LI-Ion/over 2 hours ⁴	LI-Ion/over 2 hours ⁴	LI-Ion/over 2 hours ⁴
Pointing Device	EasyPoint III	EasyPoint III	EasyPoint III	EasyPoint III	EasyPoint III
Ports (All models)	Serial, Enhanced Parallel, Keyboard/Pointing Device, External Monitor, R, USB, Audio In, Headphone Out, Mic, Convenience Base				
Intelligent Manageability	Included	Included	Included	Included	Included
Dimensions/Weight	16" x 12.5" x 9.6"/6.3 lbs.**	16" x 12.5" x 9.6"/6.3 lbs.**	2" x 12.6" x 10.2"/7.8-9 lbs.	2" x 12.6" x 10.2"/8-9.2 lbs.	2" x 12.6" x 10.2"/8-9.2 lbs.
Preinstalled Operating System [†]	Windows 95 or Windows NT 4.0 [†]	Windows 95 or Windows NT 4.0 [†]	Windows 95 or Windows NT 4.0 [†]	Windows 95 or Windows NT 4.0 [†]	Windows 95 or Windows NT 4.0 [†]
Worldwide Limited Warranty [‡]	3-Year	3-Year	3-Year	3-Year	3-Year
New Low Price [§]	\$3,299	\$4,199	\$4,399	\$5,199	\$5,599
Lease Price [¶]	\$111/mo.	\$141/mo.	\$148/mo.	\$175/mo.	\$188/mo.

*Not available on Windows NT models.
 **6.3 lbs. with weight of system.
 †Other operating systems available.
 ‡Ask your operator for Windows NT 4.0 prices.
 §For hard drives, GB=million bytes.

Enhancements & Upgrades

- ArmadaStation II **\$879**
- Compaq Leather Executive Case **\$199**
- LI-Ion Battery (7800) **\$199**
- LI-Ion Battery (7400) **\$189**
- 64MB Memory Module **\$152**

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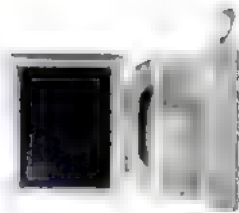
• **Intel Celeron Processors 300A or 333MHz** for industry-leading performance

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• **Fast Matrox MGA AGP Graphics Controller**



Deskpro EP Series ^{MSRP} **\$1,259**
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	Deskpro EP Series	Deskpro EP Series	Deskpro EP Series
Celeron Processor	300MHz	333MHz	333MHz
Std./Max. Memory	32MB/256MB	32MB/256MB	64MB/256MB
SMART II Hard Drive**	4.3GB	4.3GB	6.4GB
Secondary Cache	128KB	128KB	128KB
Video Graphics	Matrox MGA AGP Graphics	Matrox MGA AGP Graphics	Matrox MGA AGP Graphics
Video Memory/Max.	4MB/4MB	4MB/4MB	4MB/4MB
Total Slots/Bays	6/5	6/5	6/5
Compaq Color Monitor	S700, 17"/15.7" viewable	S700, 17"/15.7" viewable	S700, 17"/15.7" viewable
Diskette Drive	3.5" 1.44MB	3.5" 1.44MB	3.5" 1.44MB
Ports	2 Serial, 2 USB, 1 Parallel	2 Serial, 2 USB, 1 Parallel	2 Serial, 2 USB, 1 Parallel
Sound	Optional	Optional	Compaq PremierSound
CD-ROM	Optional	Optional	32X ⁶ Max Tray Load
Intelligent Manageability	Standard	Standard	Standard
Keyboard and Mouse	Standard	Standard	Standard
Preinstalled Operating System*	Windows 95	Windows 95	Windows 95
Limited Warranty*	3-Year	3-Year	3-Year

New Low Prices*	\$1,259	\$1,299	\$1,599
Lease Price*	\$42/mo.	\$44/mo.	\$54/mo.

*Other operating systems available
 **For hard drives, GB=billion bytes

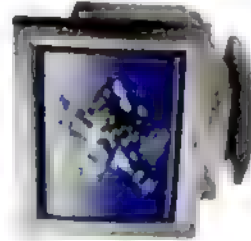
Enhancements & Upgrades



Compaq Zip Plus
 Drive **\$185**



DVD-ROM Drive & Decoder **\$399**



S900 Monitor Upgrade **\$530**

PremierSound
 PS110 Speakers **\$49**

Buy direct from Compaq at www.directplus.com/pcm2 or 1-800-888-8192

Deskpro EP Series - Pentium II

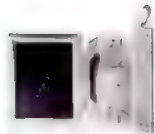
The fastest desktop performance with a versatile towerable design.

With a Pentium II Processor at 350, 400, or 450MHz, the Compaq Deskpro EP Series is a state-of-the-art desktop. It delivers excellent price/performance and maximum reliability to meet a broad range of business needs. The unique design lets you transform it from a desktop to a minitower in just seconds.



- Fastest desktop performance: Pentium II Processors 350, 400, or 450MHz
- Extremely fast Matrox Millennium AGP Graphics Controller, with up to 16MB of video memory for multi-media and graphics applications
- Up to 384MB of SDRAM memory lets you increase performance for demanding network or desktop applications
- 4.3 or 10GB** Hard Drives accommodate the demanding storage requirements of growing businesses
- Versatile design: towerable CPU lets you easily convert from a desktop to a minitower
- Combination of power and flexibility provides forward-compatible solutions for the long term

Deskpro EP Series **\$1,649**⁴⁷
Starting at



	Desktop EP Series	Desktop EP Series	Desktop EP Series
Pentium II Processor	350MHz	400MHz	450MHz
Std./Max. Memory	64MB/384MB SDRAM	64MB/384MB SDRAM	64MB/384MB SDRAM
SMART II Hard Drive**	4.3GB	10GB	10GB
Secondary Cache	512KB	512KB	512KB
Video Graphics	Matrox Millennium AGP Graphics	Matrox Millennium AGP Graphics	Matrox Millennium AGP Graphics
Video Memory/Max.	8MB/16MB	8MB/16MB	8MB/16MB
Total Slots/Bays	6/5	6/5	6/5
Compaq Color Monitor	S700, 17"/15.7" viewable	S700, 17"/15.7" viewable	S700, 17"/15.7" viewable
Diskette Drive	3.5" 1.44MB	3.5" 1.44MB	3.5" 1.44MB
Ports	2 Serial, 2 USB, 1 Parallel	2 Serial, 2 USB, 1 Parallel	2 Serial, 2 USB, 1 Parallel
Sound	Optional	Compaq PremierSound	Compaq PremierSound
CD-ROM	Optional	32X Max Tray Load	32X Max Tray Load
Intelligent Manageability	Standard	Standard	Standard
Keyboard and Mouse	Standard	Standard	Standard
Preinstalled Operating System*	Windows 95	Windows 95	Windows 95
Limited Warranty*	3-Year	3-Year	3-Year
New Low Price**	\$1,649	\$1,979	\$2,239
Lease Price*	\$55/mo.	\$66/mo.	\$71/mo.

*Other operating systems available.
**For hard drives, GB = billion bytes.

Enhancements & Upgrades

Iomega Zip Plus Drive **\$185**

DVD-ROM Drive & Decoder **\$399**

32MB Memory Module **\$79**

S900 Monitor Upgrade **\$530**

Buy direct from Compaq at www.directplus.com/pcm2 or 1-800-888-8192

Compaq C-Series Handheld PC

The fastest, easiest, and most secure way to access information while away from your PC.

What can you do when you're out of the office and need access to critical business information? Carry the Compaq C-Series Handheld PC. It's an easy way to access your files, e-mail, or faxes. It offers convenient data synchronization with your desktop or portable through serial or infrared ports. You can even use it to browse the Web.



- Monochrome and color models available. Monochrome version runs on two AA batteries for up to 20 hours of use; color version uses NiMH rechargeable batteries for up to 3 hours* of use
- Windows CE 2.0 operating system — pocket versions of Microsoft Word, Excel, PowerPoint, Internet Explorer, and InBox
- Exceptional security features — help protect your data; also includes voice-record capability
- Easy synchronization with your desktop or portable through serial or infrared ports — so you never have to input data twice
- Integrated 33.6Kbps modem lets you connect to e-mail, synchronize your calendar, and view documents, spreadsheets, and presentations from anywhere in the world
- Lightweight and easy to carry — less than 1 pound

**C-Series
Handheld PC \$499⁴**
Starting at



In Focus LP420 Presentation Solution

Use the In Focus LP420 with your C-Series Handheld PC to deliver dynamic presentations. At 6.8 pounds, it's the world's lightest full-featured data projector. It projects images at 800 x 600 resolution (up to 1024 x 768 with compression). It also features Digital Light Processing display technology, so you get 500 lumens of brightness.

In Focus LP420 (projector only) **\$4,335¹**

VGA Card

New VGA card turns your C-Series into a presentation tool. Allows projection on full-size monitor or projector.

\$220¹

Stylus 3-Pack

Misplace your stylus? Keep a spare on hand with this convenient set of extras.

\$9¹

Auto Adapter

Get things done while you're in traffic, and save your batteries for when you need them. Plugs into cigarette lighter.

\$29¹

10MB Flash RAM PC Card

Increase your storage or create secure backups of data, with 10MB of ATA-compatible Flash RAM storage.

\$125¹

	C-Series 810	C-Series 2010C
Screen	Monochrome with multi-level backlight	High-contrast 256-color display
High-Performance RISC-based MIPS Processor	Yes	Yes
Std./Max. Memory	8MB/20MB	20MB/32MB
Resolution	640 x 240	640 x 240
Modem	33.6Kbps	33.6Kbps
Power Supply	Two AA Batteries	NIMH Rechargeable Batteries
Expansion	Type II PCMCIA Slot, 16MB EDO Memory	Type II PCMCIA Slot, 16MB EDO Memory
Dimensions/Weight	1.34" x 7.32" x 3.93"/15.6 oz.	1.61" x 7.32" x 3.93"/18.6 oz.
Limited Warranty*	1-Year mail in	1-Year mail in
Low Price ¹ :	\$499	\$799
Lease Price ¹ :	\$17/mo.	\$27/mo.



NIMH Battery Pack — Monochrome

Save money on batteries with a rechargeable NIMH battery. Depending on use, get up to 20 hours of power on mono C-Series. Battery pack is compatible with monochrome model only.

\$29¹

NIMH Battery Pack — Color

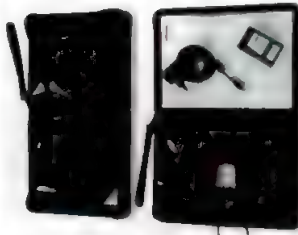
Get an additional NIMH rechargeable battery for C-Series color units.

\$29¹

AC Adapter

Plug into an AC outlet and you're all set to go — without using up battery power. Separate models available for U.S., U.K., Europe, and Australia. Each is worldwide-voltage compatible.

\$29¹



Compaq Carrying Cases

Protect your C-Series Handheld PC and related accessories in any of these attractive, durable carrying cases.

\$19¹

Compaq Slip Case (not shown)

\$49¹

Compaq Carrying Case (shown top)

\$95¹

Compaq Portfolio Case (shown bottom)

Radio

Quick, drop-in-style docking. Connects to serial and battery-charger connections, and includes an additional stylus. It also features a location for a Kensington lock.

\$39¹

Memory Expansion

Maximize performance with this 16MB EDO memory upgrade.* It gives you more storage space and increases capacity for running multiple programs.

\$85¹

*The model 810 is standard with 4MB EDO RAM and an additional 4MB in the expansion slot. The model 2010C is standard with 16MB EDO RAM and an additional 4MB in the expansion slot. Both the 810 and the 2010C are upgradable by removing the 4MB EDO RAM standard in the expansion slot and adding the 16MB EDO RAM upgrade.

Buy direct from Compaq at www.directplus.com/pcm2 or 1-800-888-8192

Professional Workstations

Workstation-class performance at desktop prices.

With the AP200, AP400, and AP500, you get everything you've been looking for in an affordable Windows NT-based professional workstation: Pentium II Processors at 350, 400, and 450MHz, fast AGP graphics support, exceptional price/performance, and versatile industrial designs that fit seamlessly into your environment.

- The latest Pentium II Processor technology: 350, 400, and 450MHz with 512KB cache

AP200 \$2,259*
Starting at

AP500 \$3,279*
Starting at

- High-performance 2D/3D graphics solutions: Matrox Millennium II, ELSA Gloria Synergy+, STB MVP Pro-128, Diamond Fire GL 4000, or Compaq PowerStorm 300

- Integrated Wide-Ultra SCSI or Ultra ATA controllers for faster access to data

- Choice of workstation-class features and options: multiprocessor-capable, high-capacity drives, 10K RPM hard drives, and high expandability

- Innovative designs for optimum flexibility and expandability in your workspace

- Tested and certified with key workstation software applications for compatibility and maximum performance



AP400 \$2,879*
Starting at

*Monitor not included in price



Enhancements & Upgrades



Compaq V75 **\$425**



32MB Memory **\$154**

Pentium II Processor
450MHz **\$1,364**

Compaq PowerStorm 300
Video Graphics Solution
\$2,970

	AP200	AP200	AP400	AP500
Pentium II Processor	400MHz	450MHz	450MHz	450MHz
Processors Standard/Supported	1	1	1/2	1/2
Std./Max. Memory	64MB/384MB SDRAM	64MB/384MB SDRAM	64MB/1GB SDRAM	64MB/1GB SDRAM
SMART II Hard Drive**	6.4GB Ultra ATA	6.4GB Ultra ATA	4.3GB Wide-Ultra SCSI	4.3GB 10K RPM Wide-Ultra SCSI
System Bus	100MHz	100MHz	100MHz	100MHz
Video Graphics	ELSA Gloria Synergy+	ELSA Gloria Synergy+	ELSA Gloria Synergy+	ELSA Gloria Synergy+
Video Memory/Max.	4MB/8MB	4MB/8MB	4MB/8MB	4MB/8MB
Total Slots/Bays	6/5	6/5	6/5	6/7
Diskette Drive	3.5" 1.44MB	3.5" 1.44MB	3.5" 1.44MB	3.5" 1.44MB
NIC	Fast Ethernet (10/100) NC3121	Fast Ethernet (10/100) NC3121	Fast Ethernet (10/100) Embedded NC3121	Fast Ethernet (10/100) Embedded NC3121
Sound	PremierSound Audio (16-bit)	PremierSound Audio (16-bit)	PremierSound Audio (16-bit)	PremierSound Audio (16-bit)
CD-ROM	32x Max	32x Max	32x Max	32x Max
Intelligent Manageability	Standard	Standard	Standard	Standard
Keyboard and Mouse	Standard	Standard	Standard	Standard
Preinstalled Operating System	Windows NT 4.0	Windows NT 4.0	Windows NT 4.0	Windows NT 4.0
Limited Warranty*	3-Year	3-Year	3-Year	3-Year
New Low Price**	\$2,259	\$2,459	\$2,879	\$3,279
Lease Price**	\$76/mo.	\$83/mo.	\$97/mo.	\$110/mo.

Other configurations also available, including your choice of graphics solution, memory, hard drive, and processor.
*For hard drives. GB=billion bytes.
**Monitor not included in price.

Buy direct from Compaq at www.directplus.com/pcm2 or 1-800-888-8192

ProSignia 200 & ProLiant 800

Easy-to-manage, affordable servers that grow with your business.

The Compaq ProSignia 200 is the affordable file and print server that delivers powerful features for about the cost of a desktop PC. The ProLiant 800 is perfect for Internet/Intranet or file and print applications. It delivers next-generation performance at a price that works with the most demanding budgets.

ProSignia 200 \$2,219¹
Starting at

- Pentium II Processor 300MHz and up to 384MB ECC memory

- Available on all Compaq servers: Compaq SmartStart makes setup easier and Compaq Insight Manager alerts you to potential hardware problems.

- Available on all Compaq servers: Automatic Server Recovery ensures maximum uptime and high availability; allows system to page for help

- Pentium II Processor 350MHz with dual-processing capabilities and up to 512MB SDRAM
- 100MHz GTL bus architecture with 50% faster memory access for improved throughput and performance
- 6 available drive bays with up to 54.6GB* internal storage; expandable to 1.15TB external storage



ProLiant 800 \$2,869¹
Starting at



ProSignia 200

Pentium II Processor	300MHz	ProLiant 800	350MHz Dual Processor capable
Std./Max. Memory	32MB ECC SIMM/384MB		64MB 100MHz ECC SDRAM/512MB
L2 Cache	512KB		512KB
Expansion Slots	5 total: 3 PCI, 1 ISA, 1 shared		6 slots: 2 PCI, 4 shared PCI/ISA
Network Controller	10/100 T/2 PCI UTP/Coax Controller (embedded)		10/100 TX UTP (embedded)
Storage Controller	Integrated Enhanced IDE or Wide-Ultra SCSI-3 Controller		Integrated Wide-Ultra SCSI-3 Controller
Storage and Expansion Bays	5 total: 1.44MB diskette drive, 1 internal 16X Max CD-ROM IDE (1) 4.3GB hard drive, and 2 available 5.25" removable media bays		8 total: (4) 1" OR (4) 1.6" drive bays, (2) 1/2-height removable media bays available, (1) 24X Max CD-ROM, (1) 1.44MB diskette drive
Maximum Storage	27GB SCSI		54.6GB SCSI
Wide-Ultra SCSI Hard Drive*	4.3GB		4.3GB
External	509.6GB		1.15TB
Interfaces	2 Serial, 1 Parallel, Mouse, Keyboard, RJ-45, BNC		2 Serial, 1 Parallel, Mouse, Keyboard, RJ-45
Graphics	1024 x 768, 256 colors in PCI slot		1024 x 768, 256 colors in PCI slot
Intelligent Manageability	Compaq Insight Manager, Automatic Server Recovery-2 (ASR-2), Pre-Failure Warranty*		Compaq Insight Manager, Automatic Server Recovery-2 (ASR-2), Pre-Failure Warranty*
Security	Power-on password, keyboard password, diskette drive control, diskette boot control, network server mode, security provision, parallel and serial interface control, administrator password, disk configuration lock		Power-on password, keyboard password, diskette drive control, diskette boot control, network server mode, security provision, parallel and serial interface control, administrator password, disk configuration lock
Server Management	SmartStart, Compaq Insight Manager		SmartStart, Compaq Insight Manager
Power Supply	280 Watts, Power Factor Corrected, CE Mark Compliant		325 Watts, Power Factor Corrected, CE Mark Compliant
Limited Warranty*	3-Year On-Site		3-Year On-Site

New Low Prices†	\$2,219	\$2,869
Lease Price*	\$75/mo.	\$95/mo.

*For hard drives, GB=billion bytes.

Enhancements & Upgrades



64MB EDO SIMM Memory
ProSignia 200 **\$215**
ProLiant 800 **\$414**



4/8GB DAT Drive **\$722**



SMART 2SL Array Controller
\$795

4.3GB Wide-Ultra SCSI-3
Hard Drive (1" high business class)
\$399

Buy direct from Compaq at www.directplus.com/pcm2 or 1-800-888-8192

ProLiant 1600 & 3000

High-performance servers that deliver maximum uptime and investment protection.

Compaq's ProLiant 1600 is the ultimate high-performance workgroup server. Run file/print, small database, remote site, Internet/Intranet, and business-critical workgroup applications easily. The Compaq ProLiant 3000 departmental server offers maximum power and expandability for high-volume file services.

ProLiant 1600 \$3,269⁴
Starting at

- Pentium II Processor 300, 350, or 400MHz with dual-processing capabilities makes this an ideal workgroup server

- Supports up to 3GB of system memory for higher performance and greater expandability (512MB on 300MHz models)

- 100MHz ECC SDRAM memory, expandable to 1GB* for memory-intensive applications (512MB EDO on 300MHz models)

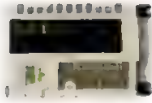
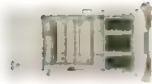
- Pentium II Processor 300 or 333MHz with dual-processing capabilities makes this a great choice as a departmental server

- Both servers offer fault-tolerant features: Hot Plug Hard Drives and optional Redundant Hot Plug Power Supplies

- Network Magazine
Product of the Year 1998

ProLiant 3000 \$4,829⁴
Starting at





ProLiant 1600

Pentium II Processor	300MHz	350MHz	400MHz	ProLiant 3000	300MHz	333MHz
Std./Max. Memory	64MB ECC EDU/512MB	64MB 100MHz ECC SDRAM/1GB	64MB 100MHz ECC SDRAM/1GB	64MB EDO ECC/512MB	64MB EDO ECC/3GB	
L2 Cache	512KB			512KB		
Expansion Slots	6 slots: 2 PCI, 4 shared PCI/ISA			8 slots: 5 PCI, 3 shared PCI/ISA		
Network Controller	10/100 TX UTP (embedded)			Netelligent 10/100 TX PCI UTP		
Storage Controller	Dual Integrated Wide-Ultra SCSI-3			Dual-Channel Integrated Wide-Ultra SCSI-3		
Storage and Expansion Bays	9 total (7 on 300MHz Model): 1.44MB diskette drive, (1) 24X Max CD-ROM, (2) 1/2-height removable media bays, (5) 1" or (2) 1.6" & (1) 1" Hot Plug Hard Drives (350/400MHz Models) (3) 1" or (3) 1.6" Hot Plug Hard Drives (300MHz Model)			12/14 total bays: 1.44MB diskette drive, (1) 16X Max CD-ROM (2) 1/2-height removable media bays, (6) 1.6" or (8) 1" Hot Plug Hard Drives		
Maximum Storage	45.5GB			109.2GB		
Wide-Ultra SCSI Hard Drive	4.3GB			9.1GB		
External	1.15TB			1.15TB		
Interfaces	2 Serial, 1 Parallel, Mouse, Keyboard, RJ-45			2 Serial, 1 Parallel, Mouse, Keyboard, RJ-45		
Graphics	1024 x 768, 256 colors in PCI slot			1024 x 768, 256 colors in PCI slot		
Manageability	Compaq Insight Manager, Automatic Server Recovery-2 (ASR-2), Pre-Failure Warranty [†]			Compaq Insight Manager, Automatic Server Recovery-2 (ASR-2), Pre-Failure Warranty [†]		
Security	Power-on password, keyboard password, diskette drive control, diskette boot control, network server mode, security provision, parallel and serial interface control, administrator password, disk configuration lock			Power-on password, keyboard password, diskette drive control, diskette boot control, network server mode, security provision, parallel and serial interface control, administrator password, disk configuration lock		
Server Management	SmartStart, Compaq Insight Manager			SmartStart, Compaq Insight Manager		
Power Supply	325 Watts, Power Factor Corrected, CE Mark Compliant			750 Watts, Power Factor Corrected, CE Mark Compliant, Hot Plug Standard		
Limited Warranty[†]	3-Year On-Site			3-Year On-Site		

New Low Price[†]	\$3,269	\$3,499	\$4,829	\$5,169
Lease Price[†]	\$110/mo.	\$117/mo.	\$162/mo.	\$169/mo.

[†]For hard drives, GB=billion bytes

Enhancements & Upgrades



64MB EDO DIMM Memory
\$369



SMART-2DH Array Controller
\$1,780



12/24GB DAT Drive
\$1,074



UPS T1500
\$669

Buy direct from Compaq at www.directplus.com/pcm2 or 1-800-888-8192

BY LUISA SIMONE



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Eleven new products that help you edit, optimize, automate, and animate graphics to produce a professional-looking site.



Image-editing programs, such as Adobe Photoshop, and illustration packages such as CorelDraw, can be used—are used—to create graphics for the Web (“Professional Graphics,” September 22, 1998). But the Web introduces a new set of challenges that none of these print veterans fully addresses. First, the Web relies on its own file formats, which provide high compression without losing much image quality. Second, many of the tasks involved in preparing graphics for a site—especially a large site—can be repetitive. Finally, many Web graphics have to do more than just look good; they also have to do something.

The Wide World of Web Graphics

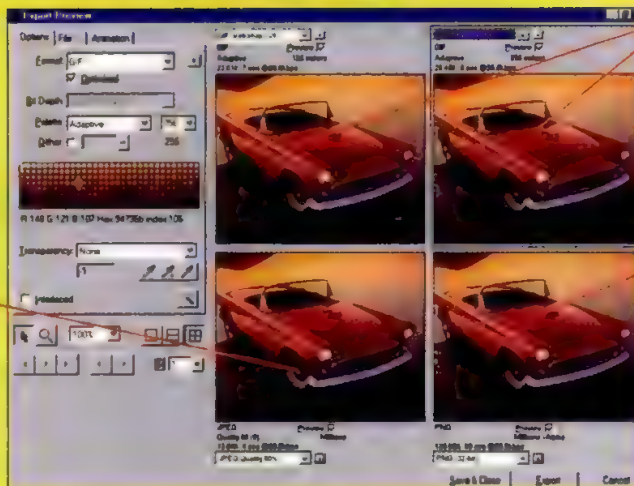
FILE PREVIEW AND FILE FORMATS

A preview shows how optimization settings will affect images. Macromedia Fireworks can display up to four previews at once. To find the best combination, you can change the file format, number of colors, the color palette, and other settings for each preview. Note the file size and estimated download time.

JPEG: Developed by the Joint Picture Experts Group, JPEG was designed specifically for compressing photographic images of up to 24-bit color (millions of colors). Unlike GIF, JPEG is a "lossy" format, meaning that it sacrifices some of the information in the image to reduce file size. But you can fine-tune quality versus compression to find the right balance.

COLOR PALETTES

Color palette controls ensure that your images look consistent and can be compressed as much as possible while preserving quality. Web graphics tools offer a range of palettes including adaptive (based on the colors that appear most often in the image), perceptual (based on the colors to which the human eye is most sensitive), and Web-safe (the 216 standard colors shared by both Macintosh and

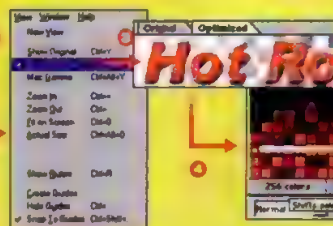


GIF: The most popular graphics format on the Web, GIF (Graphics Interchange Format) was developed by CompuServe and provides good compression without sacrificing quality. It is best suited for graphics with areas of solid color, such as clip art and logos. GIF is limited to 8-bit color but supports transparency.

PNG: PNG (Portable Network Graphic), pronounced "pling," is the most robust file format, but only Microsoft Internet Explorer 4.0 or later currently supports it without a plug-in. A lossless format that yields a higher compression rate than GIF or JPEG, PNG supports up to 32-bit images and can contain transparency or an alpha channel.



Windows PCs). Many programs also let you add or remove individual colors, create custom color palettes based on one or more images, and bias colors—a process that keeps certain colors when reducing the total number of colors in the image. In this example, we created a logo (1) and



optimized it using Adobe ImageReady. To see how it would appear in a browser on a low-resolution display, we turned on the Browser Dither option (2 & 3).



To correct the dithering on the type, we selected the type color and "shifted" that color to the closest Web-safe color (4). The result (5) was smoother type.

This may involve animation, or associated HTML code or JavaScript that turns a static image into a dynamic element.

To perform all these tasks, designers currently must resort to a hodgepodge of graphics programs and utilities. But a new category, Web graphics software, is aiming to replace this Rube Goldberg procedure. For this story, we tested 11 Web graphics tools including standalone applications, Adobe Photoshop plug-ins, and even an online service. One product, Adobe ImageStyle, didn't ship in time for our story but should be available by the time you read this (see Trends/Software in this issue).

What we discovered is that no single Web graphics program yet offers the com-

plete package. In fact, we found a lot of variation not only in the quality of their optimized images, but also in the features they offer. Adobe ImageReady offers the best color controls, but Digital Frontiers' HVS Toolkit Pro delivers the highest-quality GIF and JPEG files. Equilibrium's DeBabelizer Pro does the best job of taking menial work off your hands, but only Macromedia Fireworks comes close to covering all the bases with excellent HTML support and a good complement of image-editing and illustration tools.

There are many different strategies for delivering images on the Web. The most common strategy involves converting an image to a format that is supported by both Microsoft Internet Explorer and

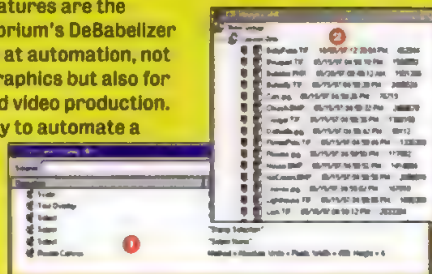
Netscape Navigator. Today, that means either GIF or JPEG. A third format, PNG, is also gaining currency, but only Internet Explorer currently supports it. Most of the programs we tested can read and write all three formats. Our tests consisted of three real-world projects: a GIF logo, a JPEG image with buttons, and a PNG banner. For all three projects, we used high-quality images from the PhotoSpin collection (888-246-1313, www.photospin.com).

When you convert an image to GIF, the program compresses the file by reducing the number of colors in the image from 24-bit (millions of colors) to 8-bit (256 colors or less). To do this without sacrificing the quality of the image, you need robust color palette controls. Because JPEG images are 24-bit, you don't need to worry about all these color palette options. Instead, most programs let you choose a balance between file size and quality. In addition to

Our Contributors: LUISA SIMONE, JAN OZER, SALLY WIENER GROTTA, and DANIEL GROTTA are contributing editors of *PC Magazine*. DIANE JECKER was the project leader, and JOHN MORRIS was the associate editor in charge of this story.

AUTOMATION

Many image-editing and optimization tasks can be repetitive when you're working on large Web sites that contain loads of graphics. Automation features are the answer. Equilibrium's DeBabelizer Pro is the best at automation, not only for Web graphics but also for multimedia and video production. The easiest way to automate a task in DeBabelizer is to perform a series of actions on one image.



The program automatically logs everything you do, and you can simply drag and drop the log onto a Script dialog box (1) to create a

new script. You then create a list of the files that you want to perform the script on, called a Batch List (2), then process the batch.

The Naming Options (3) and Save As (4) dialog boxes give you a lot of control over the attributes of the resulting files (5).

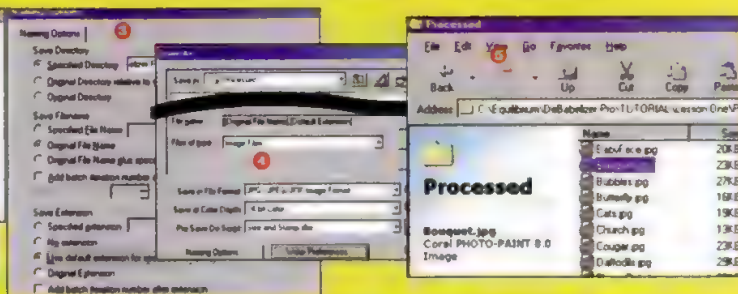
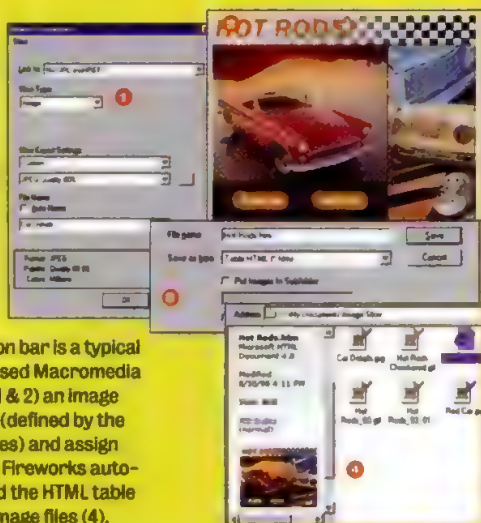


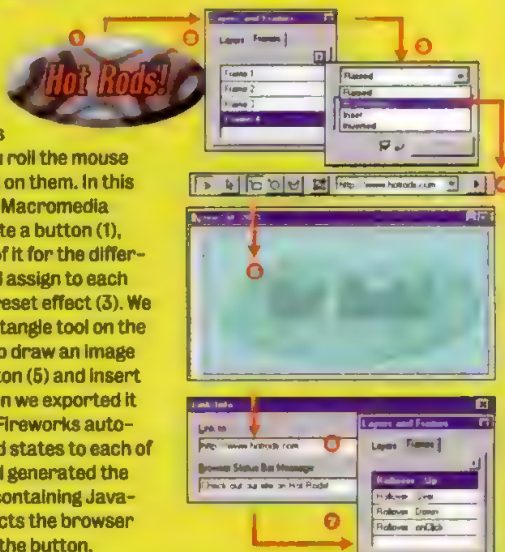
IMAGE SLICING

This lets you divide a single image into segments, which are reassembled using an HTML table. Image slicing is often used for images that contain varying elements such as photographic images, line art, and text. A navigation bar is a typical example. Here we used Macromedia Fireworks to slice (1 & 2) an image into four segments (defined by the yellow boundary lines) and assign export settings (3). Fireworks automatically generated the HTML table and the individual image files (4).



ROLLOVERS

Rollovers change the appearance of objects, such as buttons, when you roll the mouse over them or click on them. In this example, we used Macromedia Fireworks to create a button (1), make duplicates of it for the different states (2), and assign to each frame a Button Preset effect (3). We then used the Rectangle tool on the URLS toolbar (4) to draw an image map over the button (5) and insert a new link (6). When we exported it as a GIF Rollover, Fireworks automatically assigned states to each of the frames (7) and generated the necessary HTML containing JavaScript that instructs the browser on how to display the button.



still images, most Web graphics programs can also export animated GIFs.

No matter what type of file you want to create, you need an interactive preview so you can compare the source file with one or more optimized versions. The better programs also report the file size and estimated download time.

Web graphics involves much more than file optimization. When you're working on a large site, automation is a boon. In ImageReady and DeBabelizer, you can create scripts for common tasks such as cropping images, correcting color, adding backgrounds, or even inserting text or logos.

Converting one image or a batch of images into a Web format is only half the battle. You also need to incorporate the images into Web pages. Some of the programs we tested can automatically generate HTML for special types of graphics.

For instance, you can slice a single, large image into pieces and export each as a separate file. The program automatically generates an HTML table to reassemble the image in a Web browser. Other HTML-related features include image maps, as well as JavaScript rollovers—animated graphics that change their appearance as you move the mouse across them or click on them.

As a category, Web graphics software is still in its infancy and still feeling its way toward a feature set. Though no single tool yet offers everything we'd like to see, we were impressed with the category as a whole. Better-looking and more efficient Web sites can't be far behind.



Adobe ImageReady 1.0

\$200 street. Adobe Systems Inc., San Jose, CA; 800-685-3659, 408-536-6000; www.adobe.com; 500 at www.pcmag.com/infolink.

● In the murky category of Web graphics software, Adobe ImageReady stands out as a tool with a clear focus: optimizing images. ImageReady doesn't offer the breadth of features found in Macromedia Fireworks, for example, but easily makes up for that with its depth. The program's extensive color control, intelligently designed image preview, and powerful automation features make it a top-notch optimization tool.

ImageReady picks up Web graphics preparation where Adobe Photoshop leaves off. The tabbed palette interface looks and feels like Photoshop and Adobe Illustrator, and ImageReady shares Photoshop's native PSD format. It maintains



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transparent layers, and you can edit both the copy and typographic attributes of a text layer. Unfortunately, Photoshop 5.0's Layer Effects, such as drop shadows and bevels, are not in this version.

When converting images to GIF, you can control the amount of dither, specify the number of colors in a palette, and even fake anti-aliasing for a transparent GIF placed against a solid, untextured background. You can also edit color palettes directly, adding or removing colors, locking colors to prevent them from shifting when you change palettes, and "snapping" colors to their closest Web-safe equivalents. And ImageReady can bias a palette in favor of a particular area of

and estimated download time. You can tab between the original picture and the optimized version, or drag the optimized tab to the workspace to view the images side by side. The zoom and pan tools are useful when searching for artifacts. More impressively, ImageReady can simulate 256-color graphics mode in order to show you how adaptive colors will dither when viewed within a browser on low-end systems.

ImageReady generates HTML code for image tags, client-side (not server-side) image maps, and tables for sliced images. But you can't, for example, choose different output options for slices of an image, nor can ImageReady create JavaScript rollovers. In addition, URLs

are assigned to an entire layer (not a selection), making it difficult to manage large numbers of links.

Like Photoshop, ImageReady offers multiple undos through the History palette, and the Actions palette lets you record and play back actions on a new image. New with ImageReady are the easy-to-use Droplets, which let you save optimization scripts as desktop shortcuts.

ImageReady can also produce animated GIFs, but the animation features are closely tied to the layers in the PSD file format. ImageReady can tween any parameters (such as position) that are stored with the layer data, but if you edit an object on one layer, those changes aren't automatically interpolated across frames.

ImageReady should appeal to a wide range of professional users, from designers to Web masters, who already have image editing and illustration programs, but need a powerful optimization tool.—

Luisa Simone

CorelXara 2.0

\$150 street. Corel Corp., Ottawa; 800-772-6735, 613-728-3733; www.corel.com; 501 at www.pcmag.com/infolink.

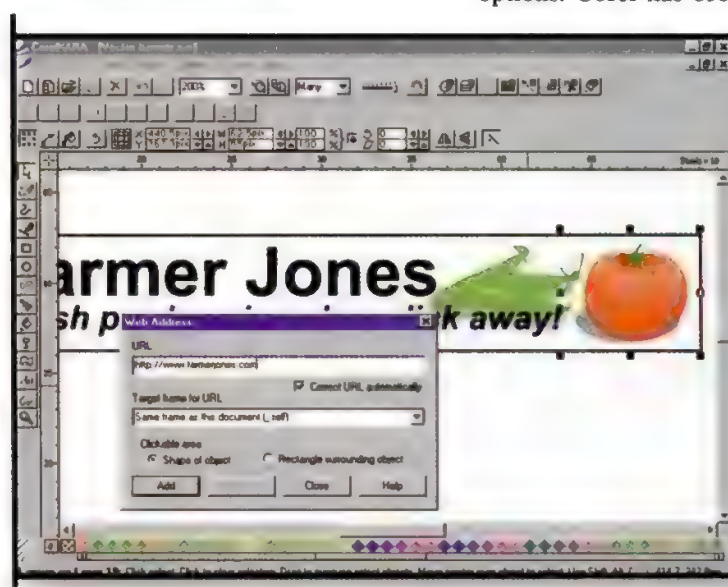
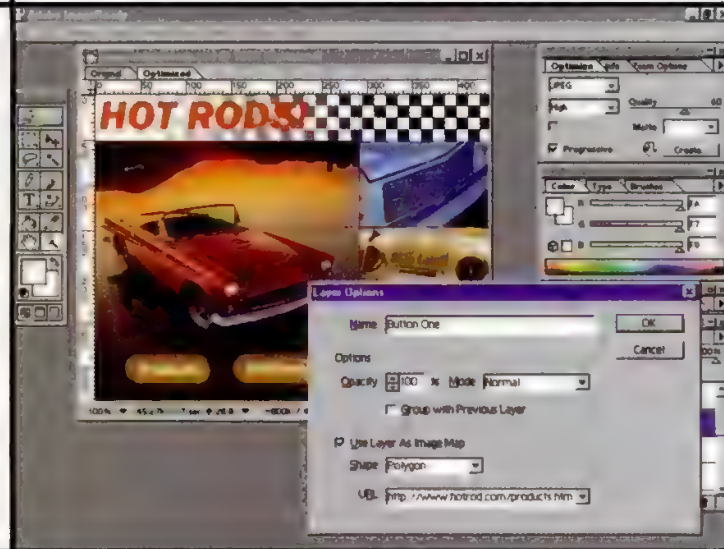
● Unlike most of the programs in this roundup, which are designed primarily for working with bitmap images, CorelXara is, at heart, an illustration tool for creating and editing vector graphics. Like its sibling program, CorelDraw, CorelXara includes a full complement of Bezier drawing tools and formatting options. Corel has broadened the pro-

an image or in favor of one image in a batch.

In addition to Web-safe and adaptive palettes, ImageReady offers selective and perceptual palettes. The latter produced excellent results on our test GIF image, which was significantly better than the image produced by Equilibrium's DeBabelizer Pro 4.5, and second only to Digital Frontiers' HVS Toolkit Pro 2. ImageReady's JPEG output was satisfactory, but we'd like to see smoothing and subsampling options. A step ahead of browsers, ImageReady boasts extensive PNG support, including true alpha channel transparency for 24-bit PNG, and indexed anti-aliasing for 8-bit PNG files. We did observe one significant shortcoming on our tests: ImageReady failed to read any alpha channels in imported images.

The product's preview reports file size

ImageReady's tabbed-palette interface will be immediately familiar to Photoshop and Illustrator users. Here you can see how the Layer Options dialog box has been modified to accommodate URLs.



CorelXara lets you assign a URL to any object in a drawing. Note the diamond-shaped, Web-safe color swatches at the bottom of the screen.

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gram's features, however, to position it as a Web graphics tool. Although CorelXara could quickly become a contender, it is not yet ready to take on market heavyweights such as Adobe ImageReady and Macromedia Fireworks.

The most obvious manifestation of CorelXara's new role is a special Export dialog box for GIF, JPEG, and PNG files. The Export dialog box displays side-by-side previews of the color-reduced or compressed file. You can switch between the two versions, adjust parameters, and inspect the result with zoom or pan tools until you find the best combination of quality and file size.

CorelXara reports the resulting file size in the Export dialog box. To see estimated download times, however, you must preview the image in your Web browser. This isn't really a problem because the command is located right in the Export dialog box. And the browser preview offers advantages: It lists download times for a variety of connection speeds, and it lets you test the validity of hyperlinks.

CorelXara offers robust but not advanced image-processing options. It supports 8-bit transparency and interlacing, offers both a Web-safe palette and an optimized palette, and lets you specify the number of colors. But it won't let you import a custom palette, bias colors, or color-reduce using a perceptual palette. You can turn dithering on or off, but you can't moderate it. Similarly, the JPEG output does not support subsampling.

Considering CorelXara's role as a vector (rather than raster) graphics application, we thought it performed acceptably with our admittedly difficult test files. Though the program can import a wide variety of file types, it stumbled on the alpha channels in our test TIFF file. To achieve the target GIF file size we had to compromise image quality, by reducing to only 28 colors or by turning off dither. But the JPEG output kept pace with the field in both quality and file size. The big surprise was our 8-bit PNG banner, which we were able to reduce to a compact 100 colors without sacrificing image quality.

In addition to still images, CorelXara can generate animated GIF files. Its drawing features such as interactive gradient fills and graduated transparency, support for Adobe Photoshop plug-ins and preset

Editors' Choice

• Macromedia Fireworks 1.0



As we learned during testing, the term Web graphics covers a lot of ground. Optimizing images is certainly one of the primary tasks, but there's a lot more to it,

including automating frequent tasks, producing HTML to support special types of graphics, and providing the right image-editing and illustration tools. Only one product we tested, Macromedia Fireworks (\$300 street), comes close to addressing all these areas—earning it our Editors' Choice.

Fireworks can import a wide variety of bitmapped and vector file formats and export GIF, JPEG, PNG, and animated GIF files. Its Export dialog box can display as many as four optimized versions of a file at once. Each preview can have different export formats and settings, and Fireworks displays the size of the optimized file and its estimated download time.

The standard color palette controls are all present in Fireworks. You can select Web-safe and adaptive palettes, snap colors to Web-safe hues, and specify the amount of dithering. The JPEG options include progressive output, a quality setting, and a smoothing filter to reduce artifacts. On our tests, Fireworks produced quality GIF and JPEG files, as well as the best PNG of the group.

But what separates Fireworks from

the pack is its features beyond optimization, especially its HTML support. Fireworks is the only product that can slice an image into segments and export them with different file formats. The program automatically creates the HTML table to reassemble the image in a browser. Similarly, Fireworks automatically generates the HTML and JavaScript for rollovers. Fireworks can also export image maps. And we were impressed with Fireworks' animation capabilities. Finally, Fireworks includes a well-rounded set of image-editing and illustration tools.

Fireworks still lacks some features, and several other products deserve honorable mention for their special capabilities. Adobe ImageReady offered the best color palette controls, including a perceptual palette and color biasing. If you already use Adobe Photoshop, Digital Frontier's HVS Toolkit Pro 2 plug-in delivers the best GIF and JPEG images. Hemera Technologies deserves kudos for addressing less-savvy users' issues with NetGraphics Studio2. Finally, if you work with a lot of images, Equilibrium's DeBabelizer Pro 4.5 offers a unique set of automation features.

envelope distortions, let you achieve some spectacular effects. But you have to do it manually: CorelXara offers no tweening.

CorelXara earns a mixed review for its HTML support. It can write the HTML command to insert an image to the Clipboard or generate the HTML code for a client-side image map—but not both, leaving us to hand-code the proper tags. Furthermore, CorelXara does not offer advanced HTML functions, such as JavaScript rollovers or sliced images.

CorelXara's real strength lies in its ability to produce a proprietary vector format

suitable for the Internet. Its Web format offers small file sizes (and fast downloads), gives the viewer zooming controls of up to 25,000 percent magnification, and incorporates URLs. Like other proprietary formats, CorelXara Web requires a browser plug-in, and you'll have to configure your Web server to identify CorelXara Web as a new MIME type.

As an optimization utility, CorelXara is still missing a few features. But its powerful vector illustration tools, coupled with solid bitmap output options, make it a promising player in the Web graphics arena.—LS

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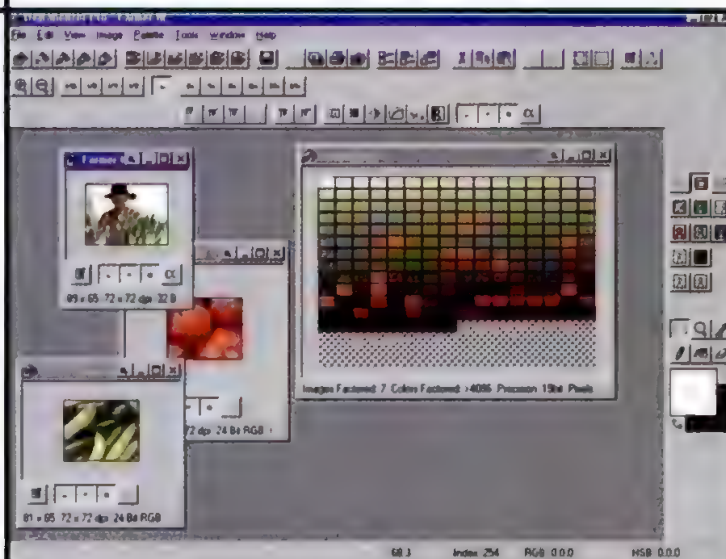
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In DeBabelizer, you can create a multi-image palette by dragging ActionArrows from open pictures into a SuperPalette window. Dragging the same image repeatedly biases color selection.

DeBabelizer Pro 4.5

\$400 street. Equilibrium, Sausalito, CA, 800-524-8651, 415-332-4343; www.equilibrium.com; 502 at www.pcmag.com/infolink.

● A production tool streamlines basic, repetitive image editing chores, and supports more than 100 raster formats, Equilibrium's DeBabelizer Pro is geared toward high-volume graphics production. DeBabelizer is unquestionably a highly efficient utility with the most robust automation features of any program reviewed here. And given its broad focus,

it's no surprise that it ignores some Web-specific features such as image slicing and JavaScript rollovers. What is surprising is that, on our tests, other packages were more adept at optimizing images.

DeBabelizer's highly automated approach to file conversion is based on scripted actions and batch lists which, despite their power, are surprisingly easy to use. The easiest way to create a script is to perform the edits you want on a sample image. DeBabelizer logs everything you do in the background so, in order to create a script, you just drag and drop the series of

steps from the log window to a New Script window. DeBabelizer also includes a set of ready-made scripts for common tasks.

A unique interface convention called the ActionArrow, which appears on the title bar of each window, lets you drop data from one window onto another window to execute commands. For example, you can drop a script ActionArrow onto a batch list—a list of files you want to work on—to process multiple images automatically. In the same way, you can create an optimized palette by dragging a picture's ActionArrow to a palette window. This is especially useful when creating a SuperPalette for a group of images, because you can bias color selection by repeatedly dragging a particular image onto the palette window.

When creating 8-bit GIF and PNG files, DeBabelizer lets you set a dither percentage or create transparent backgrounds from a specified color or alpha channel mask. But our testing revealed several curious shortcomings, the most serious being DeBabelizer's limited preview capabilities. You must first create and then apply a palette in order to determine if it contains the right number of colors. If it doesn't, your only recourse is the Undo command. Likewise, you must save a JPEG image and then reopen it in order to view the compressed version. In addition, DeBabelizer doesn't anti-alias the edges of a transparent GIF file against a color back-

Web Graphics Software

	Adobe ImageReady 1.0	CorelXara 2.0	DeBabelizer Pro 4.5	Emblaze WebCharger 1.0, Emblaze HotSpots	GIF Wizard	HVS Toolkit Pro 2	Macromedia Fireworks 1.0	MAS Media Utilities 1.20b
POWER								
Optimization	Excellent	Good	Good	Good	Good	Excellent	Good	Poor
Automation	Excellent	N/A	Excellent	N/A	Excellent	Good	Good	Fair
HTML support	Good	Good	Poor	Fair	N/A	N/A	Excellent	N/A
Image editing and illustration	Good	Excellent	N/A	N/A	N/A	N/A	Excellent	N/A
EASE								
Optimization	Good	Excellent	Fair	Excellent	Excellent	Good	Excellent	Good
Automation	Excellent	N/A	Excellent	N/A	Good	Good	Excellent	Fair
HTML support	Excellent	Good	Good	Good	N/A	N/A	Excellent	N/A
Image editing and illustration	Excellent	Good	N/A	N/A	N/A	N/A	Fair	N/A

N/A—Not applicable. The product does not have this feature.

Optimization For this task, we examine each program's ability to import standard graphic file formats such as BMP, PSD, and TIFF, as well as its ability to output to standard Web formats such as GIF, JPEG, and PNG. A strong score here also reflects the program's ability to offer standard Web-safe color palettes, adaptive palettes, and robust color control within a palette. Each program is also evaluated on its ability to fine-tune 8-bit, color-reduced images with percentage-based control over dithering, its ability to generate transparent backgrounds, and its simula-

tion of anti-aliased edges. In the case of JPEG output, we look for tools, such as smoothing filters or alternative subsampling options, that can potentially reduce artifacts.

Automation In this category, we look at the program's ability to perform repetitive tasks on a group of files. As a minimum, we expect a program to convert and optimize multiple images in batch mode. We evaluate a program's strengths based on its ability to create an audit log and report processing errors. In addition, we judge the program's ability to record robust

scripts that automate editing tasks such as scaling, cropping, correcting color casts, or adding elements such as logos or text to images in predetermined positions.

HTML support The ability to generate HTML code automatically greatly enhances the usability of Web graphics programs. For this task, we rate a range of HTML features including the ability to create hot spots, support of both client- and server-side image maps, the ability to generate HTML tables to reconstitute a sliced image in a Web browser, and the ability to generate JavaScript

ground. And it crashed when we tried to import a TIFF file with two alpha channels, because it supports up to 32-bit only.

On our tests, DeBabelizer produced a quality GIF image but failed to meet our target size. Our JPEG image exhibited some artifacts, and PNG output was poor.

In keeping with its mission as a production tool, DeBabelizer's editing tools are tailored to common prep tasks, such as trimming a picture or correcting a color cast. Instead of cropping images interactively, DeBabelizer lets you trim edges based on selected parameters, such as black edges, a common problem when scanning film. Likewise, you can add an image such as a company logo or text to a batch of images by specifying a relative location.

DeBabelizer can compile a series of still image or movie files into a GIF animation, complete with a global palette, global frame rate, and frame-differencing compression. You can even use Adobe Photoshop plug-in filters to interpolate special effects across a series of animation frames.

DeBabelizer can parse an HTML file in order to extract image filenames, and batch-optimize them. But it doesn't write any HTML code for image maps. Nor does it support image slicing and JavaScript rollovers.

Unique automation features make DeBabelizer invaluable in high-volume production environments. But for all other



In WebCharger, you can pre-serve key areas of an image, such as the Hot Rod text in our test image, by drawing protective areas around them. Sliders let you adjust quality, file size, or download time.

Web graphics tasks, you'll find better and less costly tools reviewed here.—LS

Emblaze WebCharger 1.0, Emblaze HotSpots

\$100 street each. Geo Interactive, Woodland Hills, CA; 800-576-7751, 818-703-8436; www.emblaze.com; 503 at www.pcmag.com/infoclink.

● Geo Interactive offers two Web graphics products, Emblaze WebCharger and Emblaze HotSpots, that separately address the issues of compression and interactivity, respectively. But even in their fields of specialization, these narrowly focused tools can't match the other products reviewed here.

WebCharger and HotSpots both employ a fixed-resolution interface, which looks great at 640 by 480 pixels but becomes unreadable at higher screen resolutions. We tested Version 1.0 of both programs under Windows 95, because they are not compatible with Windows 98 or NT. Geo is aware of this problem, and promises to have a new version of WebCharger (Version 1.1) available by the time you read this.

WebCharger imports a limited number of file formats and outputs only JPEG-compatible files. According to Geo, WebCharger encodes graphics files using a slightly different method than the JPEG standard in an effort to produce smaller, higher-quality images. WebCharger accomplishes this feat with unique selection tools that let you define and protect areas of a picture. The com-

pression level that you specify is applied at full strength to unprotected areas, and at partial strength to protected areas. On our tests, this procedure let us maintain legible text and sharp details but did not produce appreciably smaller JPEG files than those of other programs.

This feature, however, is compromised by a flawed interface. For example, the program doesn't preview the compression on screen; it performs compression in real time and discards data. If you compress an image too much, you can't simply increase its quality setting. Instead, you must reload the file and start from scratch.

Furthermore, you cannot associate a particular compression level with an individual selection area. Instead, you must draw selection areas and compress the picture iteratively. For example, you can protect an area at full quality, compress to 80-percent quality, draw additional protection areas at 80-percent quality, compress to 60-percent quality, and so on.

Novice users will appreciate the simple interface, where changing any one of the compression parameters (file size, quality, or download time) automatically adjusts the other two. Mid-level and advanced users, however, will not tolerate the lack of control. For example, protected areas are not completely off-limits and continue to be compressed (and degraded) as you decrease the file size. Likewise, to improve compression ratios, WebCharger applies a very strong smoothing filter (with no end-user adjustment allowed), which can result

NetGraphics Studio2	SPG Web Tools	Ulead WebRazor 1.01
Fair	Good	Good
Fair	Excellent	Good
N/A	Fair	N/A
N/A	N/A	N/A
Excellent	Good	Excellent
Excellent	Good	Good
N/A	Good	N/A
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rollovers. In each instance, we paste the resulting HTML tags into an HTML editor to evaluate the quality of the code and ensure that it gives the proper instructions to Web browsers.

Image editing and illustration. Features we seek for this task include standard editing tools for resizing, rotating and cropping, changing resolutions, and adjusting color, contrast, brightness, and saturation. We also evaluate each program's support of layers, editable text, and special effects, such as bevels, emboss, and glows, commonly used in Web graphics

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Web Graphics by the Numbers

By Sally Wiener Grotta and
Daniel Grotta

Based on the premise that it is easier to put pieces together than to build from scratch, NetStudio (\$150 street), from NetStudio Corp. (510-644-8700; www.netstudio.com), is a basic program for customizing banners, bullets, buttons, and navigation bars. The trade-off for this simplicity is that NetStudio is quite limited, offering few of the image-editing or optimization features found in other Web graphics programs.

We tested a beta version of NetStudio. The final version should be available by the time you read this.

Like Hemera Technologies' NetGraphics Studio2, reviewed in this story, NetStudio seeks to

take the complexity out of preparing graphics for the Web by selecting the most appropriate format automatically (you can override its recommendation, though). NetStudio supports GIF, JPEG, and PNG. The program automatically applies an adaptive palette to images exported in GIF or 8-bit PNG. No other color palette is offered.

What distinguishes NetStudio from the optimization tools in our main story is that this program is designed more to assemble elements for Web pages from existing components. To begin, you click on the icon for a banner, bullet, button, or button bar. To drop a color, image, or gradient, just double-click on the blue

background. You can add transparency, drop shadows, blur, and bevels, but these can only be toggled on or off and are not editable. Similarly, text controls are basic, but you can control the placement, color, and amount of blur.

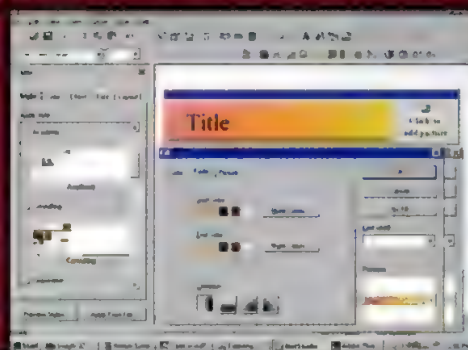
NetStudio's only image-editing tools are basic sliders for brightness, contrast, color wash, and transparency. Transparencies can be faded from opaque to fully transparent, to combine pictures seamlessly.

Although the image-editing tools are sparse, many users may often bypass them and simply use NetStudio's built-in gallery of Web page designs. With a single click, you can apply styles, colors, layout, and so on from the canned designs in the gallery. The shipping version should include about 100 design templates, and you can save your own designs to the gallery.

By loading your target Web page into NetStudio, you can preview the buttons or banners

you've created in place. You can also insert a NetStudio graphic directly into Adobe PageMill, Microsoft FrontPage 2000, or Netscape Composer.

NetStudio's fills can be colors, gradients, or images.



in fuzzy images. Nor does the program offer progressive JPEG output or batch processing of any kind.

Emblaze HotSpots allows you to add URL links and rollover effects to Web graphics. Like a multimedia authoring tool, the program has dialog-box options that let you assign predetermined behaviors to hot spots. You can display a different button picture, play a sound, or change the cursor shape on mouse-over or mouse-click.

HotSpots does not generate straightforward image maps or JavaScript code. Instead, it produces an HTML file with 14K of Java classes, which must be downloaded with the files to preserve the interactivity. Also, HotSpots contains no optimization functions whatsoever; it does not compress or slice images.

WebCharger's approach to JPEG compression is innovative. But both WebCharger and HotSpots are essentially one-trick ponies that do not offer the features or ease of use found in other comparably priced Web graphics tools in this roundup.—LS

GIF Wizard

Pricing varies by service. Raspberry Hill Publishing Inc., Newton, NJ; 973-579-7994; www.gifwizard.com; 504 at www.pcmag.com/infolink.

● The only online compression service in our roundup, Raspberry Hill's GIF Wizard is ideal for nontechnical users and Webmasters seeking third-party monitoring of the compression efficiency of images on their sites. But those seeking top-quality still images should look elsewhere: GIF Wizard received mediocre scores on our quality comparisons.

Raspberry Hill's services start at \$14.95 for 25 images, or \$29 per month or \$79 per year for a single Web site. Weekly or monthly site checks cost more, or you can encode single test images for less than \$1 by purchasing a token from Raspberry Hill.

After paying the fee, you log on to GIF Wizard and submit images or GIF animations from disk, or specify a URL. For all files, you can specify your page's background color, resize to a new resolution, and select from five levels of smoothing

filters. For JPEG images, you choose between standard and progressive.

For GIF or animated GIF files, you can output with best-fit colors, a Web-safe palette, or dithered, browser-safe colors (for low-resolution displays). You can't create a master palette for a group of images, though. If you input interlaced GIFs, the service will output interlaced GIFs; otherwise, they're noninterlaced.

If you submit a single file, GIF Wizard returns a page with your source image and several images encoded to progressively lower palette colors (GIF) or quality levels (JPEG). If you don't meet your quality or size targets, you can request additional samples. Once you're satisfied, you download the image using your browser's normal image-save capabilities. If you submit a URL, the service returns a listing of all images on your site, each containing an estimate of the potential file-size savings.

On our quality comparison tests, GIF Wizard produced good GIF images but only fair JPEG images. The quality of animated GIF output was excellent, howev-



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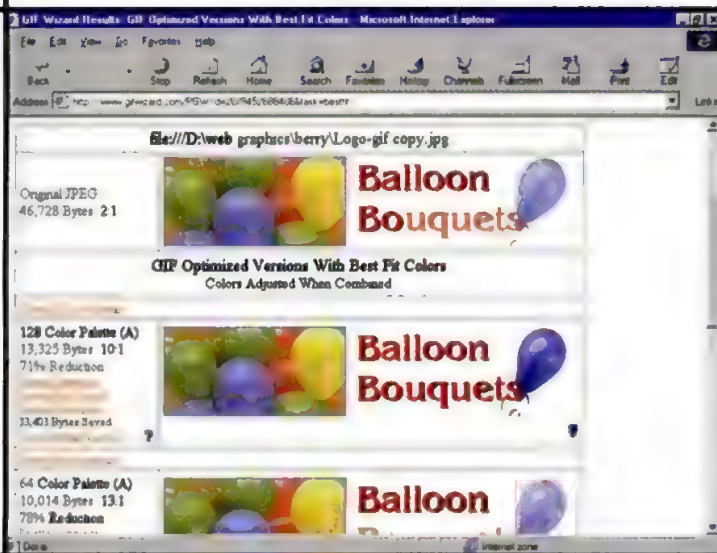
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An online service, **GIF Wizard** provides a series of optimized images. You can choose the one that best meets your target file size and quality requirements.

er, with none of the dithering that marred the output of other products. This makes GIF Wizard worth a look for all heavy users of animated GIFs.

Unless your Web site was created by the most compression-savvy designer, it probably contains some images that are unnecessarily large. Standalone programs such as Adobe ImageReady and Macromedia Fireworks offer more control and better output quality. But for quick and easy file compression, GIF Wizard is an attractive alternative.—*Jan Ozer*

HVS Toolkit Pro 2

\$130 street. Digital Frontiers, Evanston, IL; 847-328-0890; www.digfrontiers.com; 505 at www.pcmag.com/infolink.

● With its obscure controls, such as detail and strength prefilters, Digital Frontiers' HVS Toolkit Pro is a dream come true for those inclined to tinker with graphics for hours on end. HVS, which consists of two Photoshop plug-ins, isn't the easiest tool to use, but it did produce excellent images in both GIF and JPEG tests.

Accessed from either Photoshop's filter menu or its export screen, both plug-ins are floating windows with optimization controls and a single image window that toggles between source and optimized views. Unfortunately, you can't zoom in on the image preview, so getting everything right takes some trial and error.

Both tools can be automated with Photoshop Actions. ColorGIF can apply GIF compression to images directly or export to a new GIF file, whereas the

JPEG plug-in can only export a new file.

ColorGIF can apply different compression parameters to different image regions or Photoshop layers and allows variable dithering levels and thresholding, which combines colors at the upper and lower levels of the color spectrum. You can choose the default Windows or Macintosh palettes, a Web-safe palette, or custom palettes based on one or more images.

The options for compressing JPEGs are numerous. HVS JPEG offers progressive and standard encoding, prefiltering, and several choices of quantization tables. Even when making the most minor adjustments to these settings, we sometimes observed significant jumps in the

file size, which made it tough to hit the target file size on our tests. We also saw up to a 5K difference between the estimated file size and the actual size of the file HVS JPEG produced.

HVS was one of the slower programs we tested, often requiring up to 15 seconds longer than other products to generate a preview of a GIF image. But these are relatively minor quibbles, and we found that the output quality was well worth the wait. HVS Toolkit was the only product that yielded excellent results on both our GIF and JPEG tests. Even the smallest GIF (9K) still looked better than larger files produced by competitors. And when we ratcheted the JPEG file down to a svelte 35K, it was still entirely acceptable.

HVS lacks many features found in other programs here. But if all you want is the absolute best GIF and JPEG optimization, and you don't mind rolling up your sleeves a bit, HVS is the best choice.—*JO*

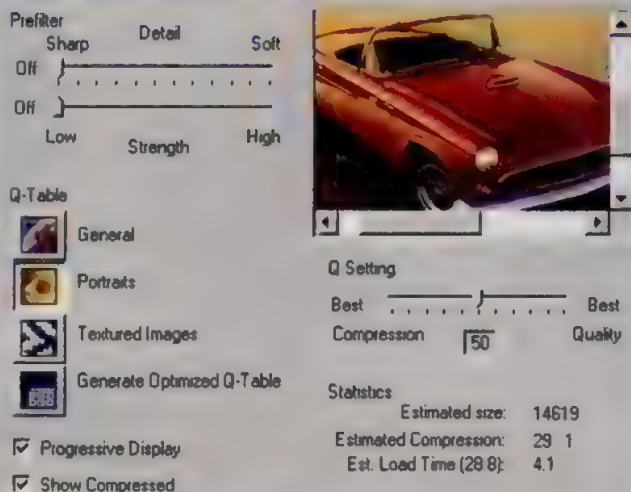
Macromedia Fireworks 1.0

\$300 street. Macromedia Inc., San Francisco; 800-888-9335, 415-252-2000; www.macromedia.com; 506 at www.pcmag.com/infolink.



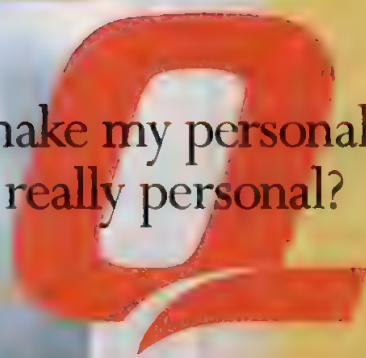
Professional artists currently use a mix of illustration, image editing, animation, file conversion, and optimization programs to produce Web graphics. With Macromedia Fireworks, Macromedia is aiming to incorporate all of these functions into one program. Fireworks (\$300 street)

HVS JPEG File Export



HVS ColorGIF and JPEG (pictured here) offer some unusual controls and a tiny preview window, but they deliver excellent quality.

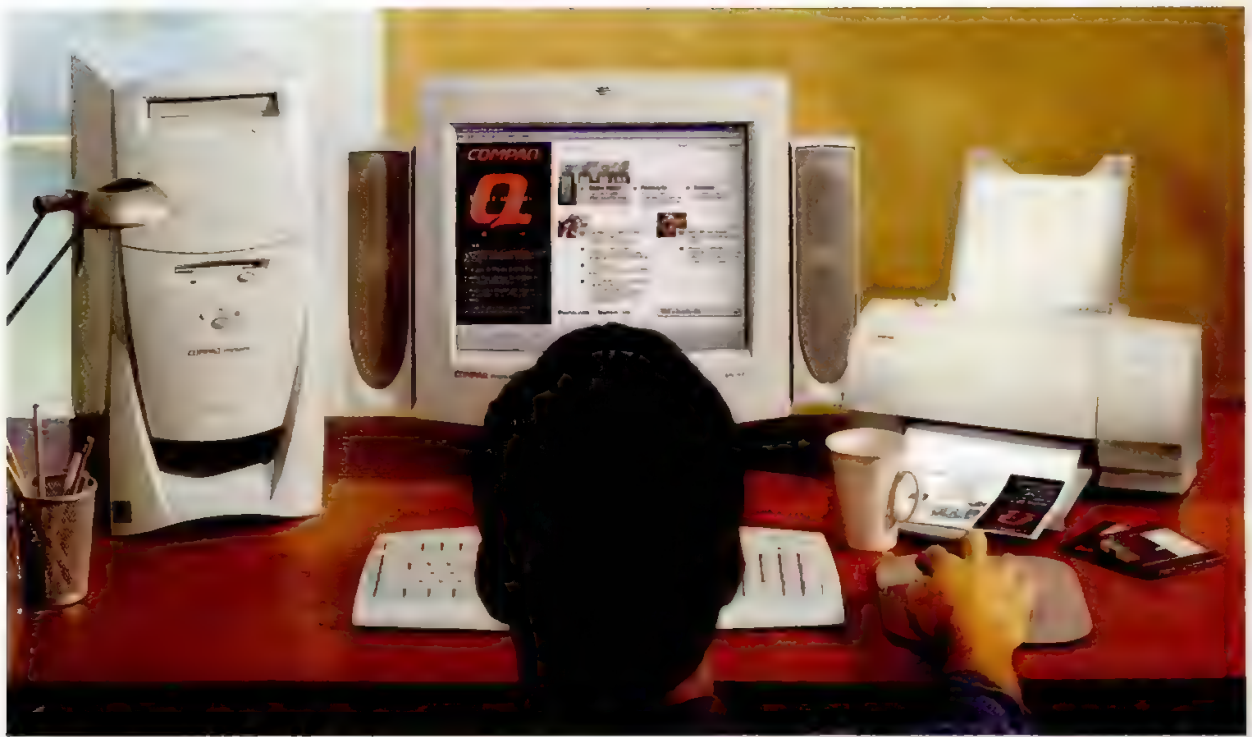
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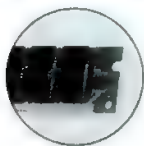


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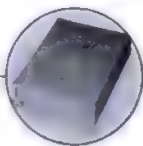
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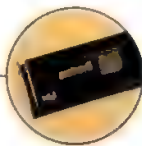
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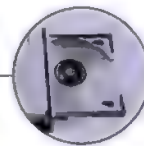
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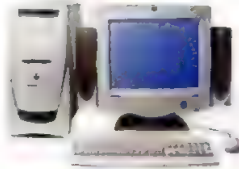
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Graphics Software Gets Down to Business

By Sally Wiener Grotta and Daniel Grotta

Even if you own a small business, your customers or potential clients expect a big-business look. But few businesspeople have the time to learn a complex graphics program such as Adobe Photoshop. And consumer-level products tend to be too simplistic or only offer projects appropriate for home use. A third category of

editor that offers a powerful suite of image-editing tools (800-622-2793; www.jasc.com) at a fraction of the price of Adobe Photoshop. But for novices, the interface may take some getting used to.

Paint Shop Pro's image-editing tools cover the full range of picture adjustments and corrections. Painting is simple and direct yet highly customizable, with extensive control over

options, including blend modes and transparency levels. Paint Shop Pro also includes numerous selection tools, including a Smart Edge finder.

The Filter Browser allows you to preview how a series of special effects will alter your image. The Drop Shadow tool provides control over color, opacity, blur, and offset.

Version 5.0 adds support for layers—bringing Paint Shop Pro one step closer to professional image-editing programs—and also Animation Shop, for generating animated GIFs for the Web.

Microsoft PhotoDraw 2000

- Microsoft PhotoDraw 2000 (\$150 street) is for businesspeople who want to produce graphics quickly without learning the ins and outs of bitmap- and vector-based tools (800-426-9400; www.microsoft.com). In addition to providing image editing, PhotoDraw 2000 inte-

icons. The Picture Gallery displays thumbnails of all open pictures and provides access to each image's object list.

When you're painting, each stroke is an object filled with a texture. It remains editable, allowing you to change its size, shape, color, texture, or angle.

PhotoDraw 2000 offers a large library of effects, all of which can be applied to any object. Text is clean and crisp, and even after you add effects, it remains editable. PhotoDraw 2000 also has an edge-finding selection tool.

The template library includes Web banners, mastheads, bullets, and buttons. And the Save for Use In... wizard helps you prep, size, and choose file formats for your images.

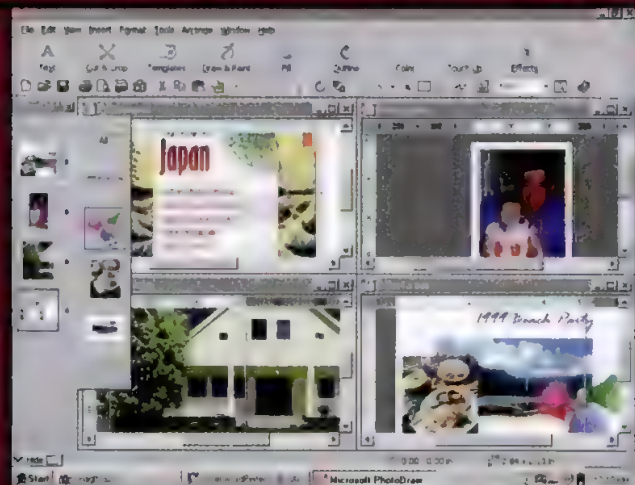
PhotoImpact 4.2

- A high-powered image processor, PhotoImpact 4.2 (\$100 street) has an extensive feature set (800-858-5323, www.ulead.com). Emphasizing efficiency, it gives the user fast and full control over images.

Commands in PhotoImpact are easily accessible, streamlining common actions. The EasyPalette offers effects and tools that can be dragged and dropped onto images. Brush styles are also defined in the EasyPalette.

The text tool and effects are powerful and easy to use. Any type in your image can be reshaped by using EasyPalette thumbnails or by manipulating its eight-point vector envelope.

Various Web tools, such as a Button Designer, are included. In the Layer Manager, you can assign URLs to objects, while the HTML Image Assistant generates the appropriate HTML. PhotoImpact also includes SmartSaver, the image-optimization program.

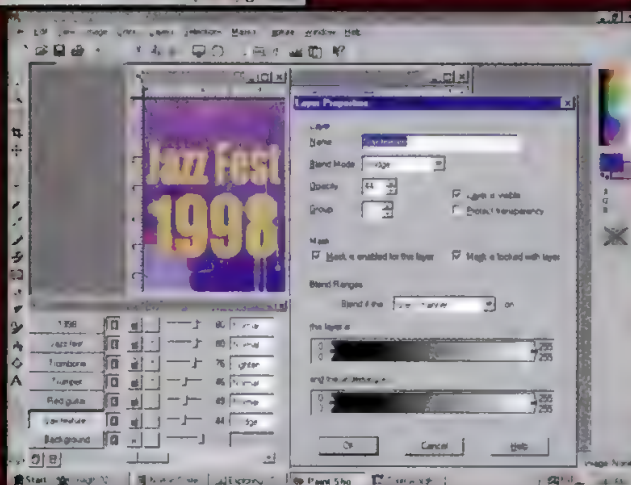


PhotoDraw 2000 has a highly graphical interface. The toolbar at the top provides you with quick access to tools.

graphics software has evolved to meet the needs of these midrange users, who know their way around a PC but don't want to become graphics gurus. Three programs—Jasc Software's Paint Shop Pro 5.0, Microsoft PhotoDraw 2000, and Ulead Systems' PhotoImpact 4.2—fall into this business graphics category. Each of these includes a mix of features for both print and the Web.

Paint Shop Pro 5.0

- Paint Shop Pro 5.0 (\$80 street) is a traditional image



Paint Shop Pro supplies powerful compositing tools, including in-depth controls in the layers palette.

such elements as color.

The compositing tools are equally powerful. The layers palette offers all the standard

grates illustration and 3-D tools.

PhotoDraw's interface is very graphical, with a Visual menu that offers task-related

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SUMMARY OF FEATURES

Web Graphics Software



■ YES ■ NO	Adobe ImageReady 1.0	CorelXara 2.0	DeBabelizer Pro 4.5	Emblaze WebCharger 1.0, Emblaze HotSpots	GIF Wizard	HVS Toolkit Pro 2	Macromedia Fireworks 1.0	MAS Media Utilities 1.20b
Price	\$200 street	\$150 street	\$400 street	\$100 street, each	Pricing varies by service	\$130 street	\$300 street	\$100 street
Product type	Standalone program	Standalone program	Standalone program	Two standalone programs	Online service	Photoshop plug-in	Standalone program	Standalone program
Formats								
Imports raster formats:								
GIF/JPEG/PNG	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
BMP/FPX/PCX	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
PSD/TIFF/others	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Imports vector formats:								
AI/CDR/CMX	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
DRW/EPS/PDF	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
WMF/others	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Exports:								
GIF/Transparent GIF/Interlaced GIF	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹ N/A ¹	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
JPEG/Progressive JPEG	■ ■ ■	■ ■ ■	■ ■ ■	(WebCharger)	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
PNG/PNG transparency/Alpha channels	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹ N/A ¹	N/A ¹ N/A ¹	N/A ¹ N/A ¹	■ ■ ■	N/A ¹ N/A ¹
Animated GIF/Delta compression/ Frame rate	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹ N/A ¹	■ ■ ■	N/A ¹ N/A ¹	■ ■ ■	■ ■ ■
Proprietary viewing format	■	(requires browser plug-in)	■	■	■	■	■	■
Optimization								
Adaptive palette/Web-safe palette	■ ■ ■	■ ■ ■	■ ■ ■	N/A ²	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Snap to Web color palette	■ ■ ■	■ ■ ■	■ ■ ■	N/A ²	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Can create one palette from multiple images	■ ■ ■	■ ■ ■	■ ■ ■	N/A ²	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Can bias color selection/Can slice images	■ ■ ■	■ ■ ■	■ ■ ■	N/A ²	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Can compress selected areas of image	■ ■ ■	■ ■ ■	■ ■ ■	(WebCharger)	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
User can set dither percent/number of colors	■ ■ ■	■ ■ ■	■ ■ ■	N/A ²	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Can batch-process from one directory	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Can batch-process from multiple directories	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Interactive image preview/Download time preview	■ ■ ■	■ ■ ■	■ ■ ■	(WebCharger)	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Number of previews available at once	1	2	N/A ¹	1	6	1	4	N/A ¹
View in browser preview	■ ■ ■	■ ■ ■	N/A ¹	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹
Image-editing/animation tools								
Multiple undos	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	■ ■ ■	■ ■ ■	■ ■ ■
Supports layers/imported masks	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Text/Brushes/Geometric shapes	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Gradient/texture fills	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Crop/Resize	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Drop shadow/Bevel/Emboss	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Set transparency	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	■ ■ ■	■ ■ ■	■ ■ ■
Image enhancement (or correction) filters	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Artistic filters	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Adobe Photoshop plug-ins	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ³	■ ■ ■	■ ■ ■
Scripting	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	■ ■ ■	■ ■ ■	■ ■ ■
Animation tools:								
Tweening	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ¹	■ ■ ■	■ ■ ■	N/A ¹
Transition effects	■ ■ ■	■ ■ ■	■ ■ ■	N/A ¹	N/A ¹	■ ■ ■	■ ■ ■	N/A ¹
HTML features								
Client-side/server-side image maps	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
HTML code/HTML tables	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
User can create JavaScript rollovers	■ ■ ■	■ ■ ■	■ ■ ■	(requires Java classes)	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■

N/A¹—Not applicable: The product does not have this feature. N/A²—Not applicable: This feature applies to GIF and PNG only. N/A³—Not applicable: This feature is provided in Photoshop.
* Version 1.21 of MAS Media Utilities supports PNG and PNG transparency but not alpha channels.



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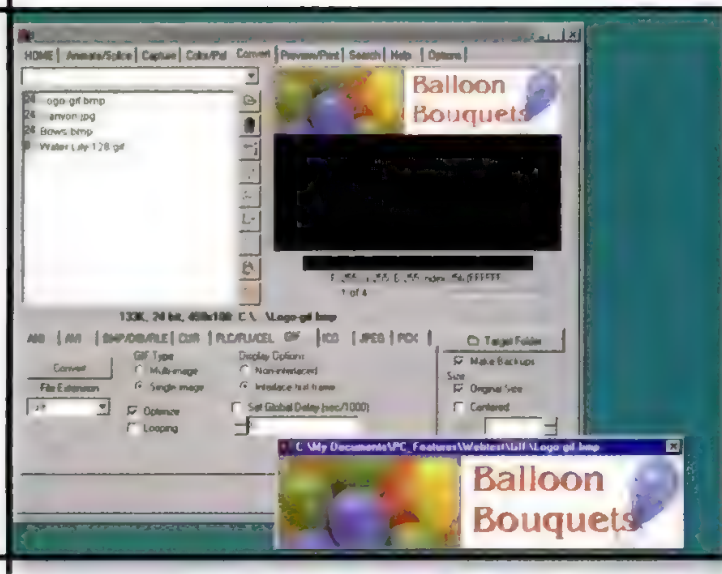
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MAS Media's file list does double duty as a batch list. The files listed will be converted to the format specified in the tabbed palette below. Notice that the exported files can be viewed only from a separate window, and only at 100 percent magnification.

mouse-over or mouse-down.

Fireworks is not without its shortcomings. Designed to create low-resolution RGB images for screen display, it isn't suitable for high-resolution CMYK print output. And the interface could do a better job of distinguishing between raster and vector modes more clearly.

But no other Web graphics tool offers the breadth of features found in this product. If you plan to buy only one Web graphics package, get Fireworks.—LS

MAS Media Utilities 1.20b

\$100 street. Paul Mace Software Inc., Ashland, OR; 800-944-0191, 541-488-2322; www.pmac.com; 507 at www.pcmag.com/infolink.

● MAS Media Utilities is a graphics conversion and image-capture program that places emphasis on multimedia and animation formats. Within its proclaimed area of specialization, MAS Media offers several unique and powerful functions. But when it comes to Web optimization, MAS Media lacks what we consider to be essential functions.

Designed around a tabbed interface that switches you between discrete tasks or between different options for each task, all of the program's commands are in plain view. This intuitive-looking interface doesn't simplify tasks, however. Essentially, the tabbed interface prevents you from performing multiple tasks on the same file. For example, during testing we could not convert a 24-bit BMP file to a color-reduced GIF file in a single step.

Instead, we were forced to convert to a 256-color GIF, then switch to a different tab, import the GIF file we just created, and change the bit depth. Moreover, the tabbed interface makes it impossible to perform more than one operation on a group of files at any given time.

The Capture module lets you save sequential screen shots that are written directly to a movie format, such as animated GIF or AVI. Our tests showed that this function is highly dependent on system resources and the size of the window targeted for capture. Nevertheless, we successfully produced an AVI movie, complete with a captured cursor, that was suitable for use as a multimedia tutorial.

MAS Media can also convert between a number of different motion formats, including AVI, GIF, FLC, and ICO. Both still-image and motion formats can be compiled into a movie. We produced an animated GIF file from a series of imported images, with a global palette and differing delays for each frame.

MAS Media Utilities falls short, however, in areas more closely related to Web graphics production. It lacks support for many common still-image formats including TIFF, and it doesn't export JPEG images. It does not dither colors or create transparent areas in 8-bit GIF files (though it will preserve transparency in an imported GIF). And MAS Media does not output any HTML to help you incorporate images into Web pages.

We were also concerned by the lack of

an interactive preview. Even after you have converted a file, you must reload it to view it. Furthermore, you must view it in a separate window that cannot be zoomed.

Though MAS Media offers a Super Palette function, it can create only a common palette from already-indexed files, and it cannot bias the color selection in any way. By default, MAS Media creates an adaptive palette when optimizing images. You can apply a Web-safe color palette directly from the Color Palette tab only after you've already optimized the image, not from the initial file conversion dialog box.

Furthermore, the version that we tested offered very few options for color reduction (we could choose between 2, 16, and 256 colors) and did not support the PNG. As a result, MAS Media performed poorly on our test images. For example, the GIF image did not meet our target file size and also exhibited noticeable posterization.

After we'd completed our story, Paul Mace Software released an update that addresses some of the program's weaknesses. Version 1.21 supports PNG, lets you select transparency, and provides more choices for reducing the number of colors in an indexed image.

Even with these important enhancements, MAS Media can't match the features or ease of use of other Web graphics programs reviewed here.—LS

NetGraphics Studio2

\$70 street. Hemera Technologies, Quebec, Canada; 819-772-8200; www.hemera.com; 508 at www.pcmag.com/infolink.

● Seeking to bring some simplicity to the complex world of Web graphics, Hemera Technologies' NetGraphics Studio2 emphasizes ease of use. NetGraphics Optimizer, one of the two components that make up NetGraphics, is based entirely on a wizard that walks users through the process of prepping images for the Web. This makes NetGraphics ideal for graphics novices, but more experienced designers will want a more flexible and powerful solution.

NetGraphics Optimizer always suggests the best output format, JPEG or GIF, depending upon image content. Each screen focuses on a single operation, such as resizing or color-reducing a picture. And at any point it is possible to backtrack and

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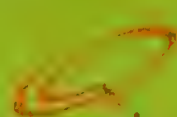
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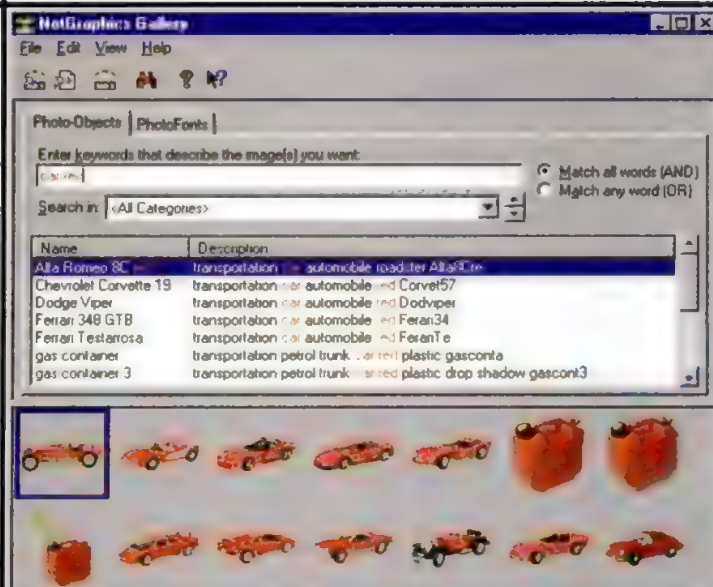
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NetGraphics Gallery, a companion to NetGraphics Optimizer, lets you search for images in a 2,000-file collection of photo-realistic clip art. Notice the simple AND/OR option buttons for creating Boolean search strings.

cult choice between a poor color match or serious posterization.

With the exception of cropping, resizing, and mirror functions, NetGraphics Optimizer offers no image-editing tools. However, its companion program, NetGraphics Gallery, can help dress up a Web site. It consists of a collection of 2,000 "photo-objects" (photo-realistic pieces of clip art) and PhotoFonts, a type program that fills TrueType outlines with a photographic image. All of the pictures in the photo-object collection come complete with transparent (alpha channel) backgrounds. The gallery is augmented by a powerful but easy-to-use search engine that supports Boolean searches.

NetGraphics Studio2 doesn't break any new technological ground, but it succeeds in making image optimization so easy you don't need to know the difference between a GIF and a JPEG.—LS

SPG Web Tools

\$199 list. SPG Inc., Miami; 305-362-6602; www.spg-net.com; 509 at www.pcmag.com/infolink.

● Although it is an add-on to Adobe Photoshop, SPG Web Tools is a versatile, powerful program in its own right. Web Tools offers advanced features such as image slicing and remote image management, excellent automation, and the highest level of Adobe Photoshop integration that we've seen. Web Tools' animated GIF files are among the best in the roundup, but other programs produce better GIF and JPEG images, and Web Tools lacks support for PNG export.

change compression parameters.

Although NetGraphics Optimizer is clearly targeted at nonprofessionals, it offers several powerful features. Our favorites include the ability to import a wide range of file formats, use imported alpha channel masks to create transparent GIFs, keep track of both file size and download time while changing compression parameters, and preview an image in your Web browser. NetGraphics can even simulate a download to demonstrate how quickly the image will load on an end user's machine.

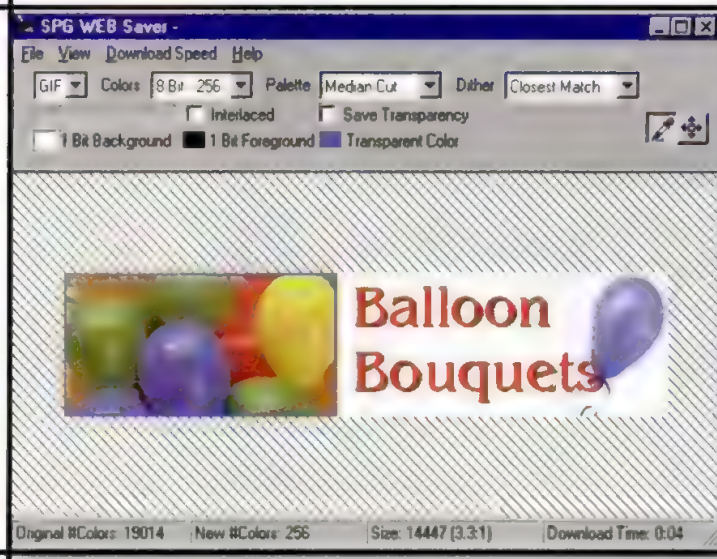
A particularly advanced feature is the program's ability to anti-alias the edge of a transparent GIF picture against a solid-color or textured background. Once again, NetGraphics keeps it simple. To smooth the edges, just point at the image tile used as the background, any solid color in the color palette, or the HTML file containing the background.

However, there are some features that need refinement. Though you can toggle between a view of the original image and a preview of the compressed file, you can't view them side by side. Nor can you zoom in for a closer look at potential artifacts. NetGraphics has no internal tools to generate transparency based on selection areas or palette color slots. Nor will it let you specify the dithering amount when color-reducing a file for GIF output; dithering's either on or off. And while it is convenient to drag and drop a com-

pressed file from the Optimizer window into an HTML editor, we still wish the program generated HTML code for you.

In many cases these limitations are deliberate in order to maintain the program's ease of use. For example, NetGraphics supports only adaptive palettes when color-reducing a picture, because this produces the closest match to the original. But it doesn't help much if you need to make multiple images look consistent.

We found NetGraphics' JPEG files to be within industry standards for both file size and quality. In order to reach our target GIF file size, however, we had to reduce the logo image to only 23 colors or turn off dithering. This left us with a diffi-



A plug-in for Photoshop, SPG Web Tools has most of the basics for optimizing GIF images, but it lacks some features. For example, you can only select a bit depth, not an exact number of colors.



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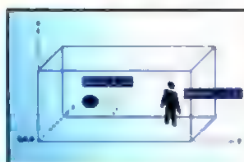
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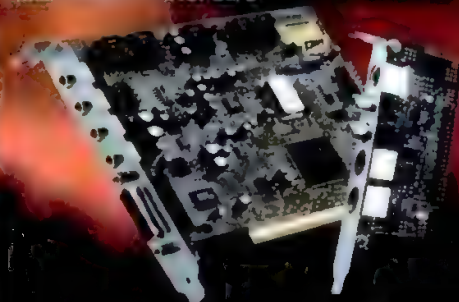
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- Full bass, treble, and effects controls available for all audio sources

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- Customizable effects architecture allows audio effects and channel control
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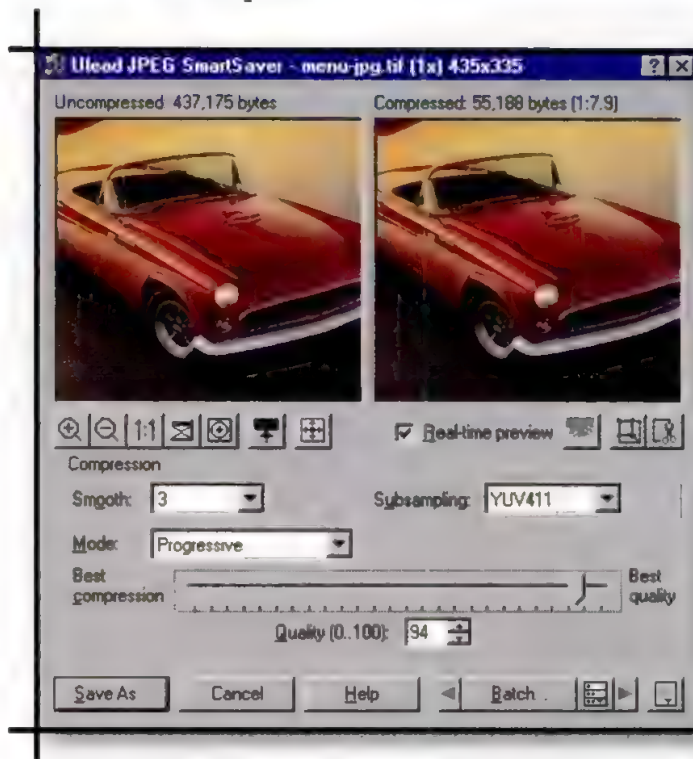
You access Web Saver and other Web Tools utilities from Photoshop's filter menu, launching a floating screen with a cumbersome preview window and encoding controls. You can continue to work in Photoshop while running any of the plug-ins, so Web Tools feels almost like a native feature of Photoshop; by contrast, Digital Frontiers' HVS Toolkit Pro 2 takes over when you activate it. Being able to configure the background of all tools to simulate the color or wallpaper of a target Web page is also useful.

When creating GIF files, you can set the bit depth, but you can't specify the exact number of colors, which makes it difficult to compress images with precision. Although you can load and save a palette file, you can't create a master palette for multiple images. The program does offer a useful collection of canned palette options, though, along with the normal dither choices of diffusion, pattern, or none. JPEG encoding options include quality-level settings on a scale of 1 to 100, smoothing, and progressive encoding.

Both GIF and JPEG encoding can be batch-processed or run in semiautomatic mode, in which the program sequentially loads files, allowing you to select encoding parameters for each file. Encoding quality was a touch above average, and Web Tools received a *good* rating in both GIF and JPEG jury tests. The program doesn't currently support the PNG format, but SPG plans to add this feature in the near future.

Web Tools' animator doesn't let you set the number of colors in an animated GIF, forcing you to drag and drop files between the animator and GIF Web Saver, which is inconvenient. But the program offers a unique, lossy save option that produces very small animated GIF files without significantly degrading quality. It also supports transitions and flare animation.

Relatively expensive but extremely functional, Web Tools has three key strengths: Photoshop integration, automation, and highly compact GIF animation. But those seeking a plug-in to wring the last bit of quality from their GIF and JPEG files should look to Digital Frontiers' HVS Toolkit Pro 2 instead.—JO



Ulead WebRazor boasts a well-designed interface that includes a side-by-side preview dialog box for comparing the source image to the optimized version.

Ulead WebRazor 1.01

\$89 download. Ulead Systems, Torrance, CA; 800-858-5323, 310-523-9393; www.ulead.com; 510 at www.pcmag.com/infolink.

● A suite of standalone utilities and plug-ins for Adobe Photoshop, Ulead WebRazor 1.01 includes a full-featured optimization tool—Ulead SmartSaver 3.0—as well as an excellent GIF animator and other utilities. WebRazor offers one of the best interfaces of the programs we tested, but it is missing some features and its GIF and PNG output is subpar.

In addition to SmartSaver and GIF Animator, WebRazor includes Ulead Photo Viewer 4.0, Ulead Photo Explorer 4.2, and Ulead Web.Plugins 1.0. All of the components offer a highly usable interface.

SmartSaver displays the source and an optimized preview in side-by-side windows. When you're experimenting with optimization parameters, the preview provides real-time updates. SmartSaver also allows you to zoom and move around an image, to optimize portions of it.

Used as a standalone applet, SmartSaver can batch-process files, but not from within Photoshop. In Photoshop, however, it can compress the same file sequentially, dropping quality or palette colors successively until you reach the optimal balance.

SmartSaver outputs transparent and

interlaced GIF files and can blend the output into a background image or color. You can use a Web-safe palette or an existing palette file, or you can let SmartSaver create an optimal palette that can be saved. But you can't create a master palette for multiple files, nor can you edit palette files. You can choose among pattern, diffusion, or no dithering, as well as smoothing. SmartSaver provides similar options for 8-bit and 24-bit PNG export.

JPEG controls include three modes of smoothing (standard, standard optimized, and progressive), a quality-versus-compression slider bar, and the option to subsample to YUV color spaces, an alternative to RGB used in video.

In our comparison tests, SmartSaver's GIF output was highly dithered, rating only fair. PNG output was also only fair. However, the program's JPEG output rivals that of Digital Frontiers' HVS Toolkit Pro, the leader in this category.

The included GIF Animator is fast and simple, working with sequential bitmaps or video files. During optimization, the program creates a superpalette for the selected number of colors and eliminates redundant pixels. WebRazor is a capable suite that deserves high marks for usability, but other products provide better color indexing and higher-quality GIF output.—JO

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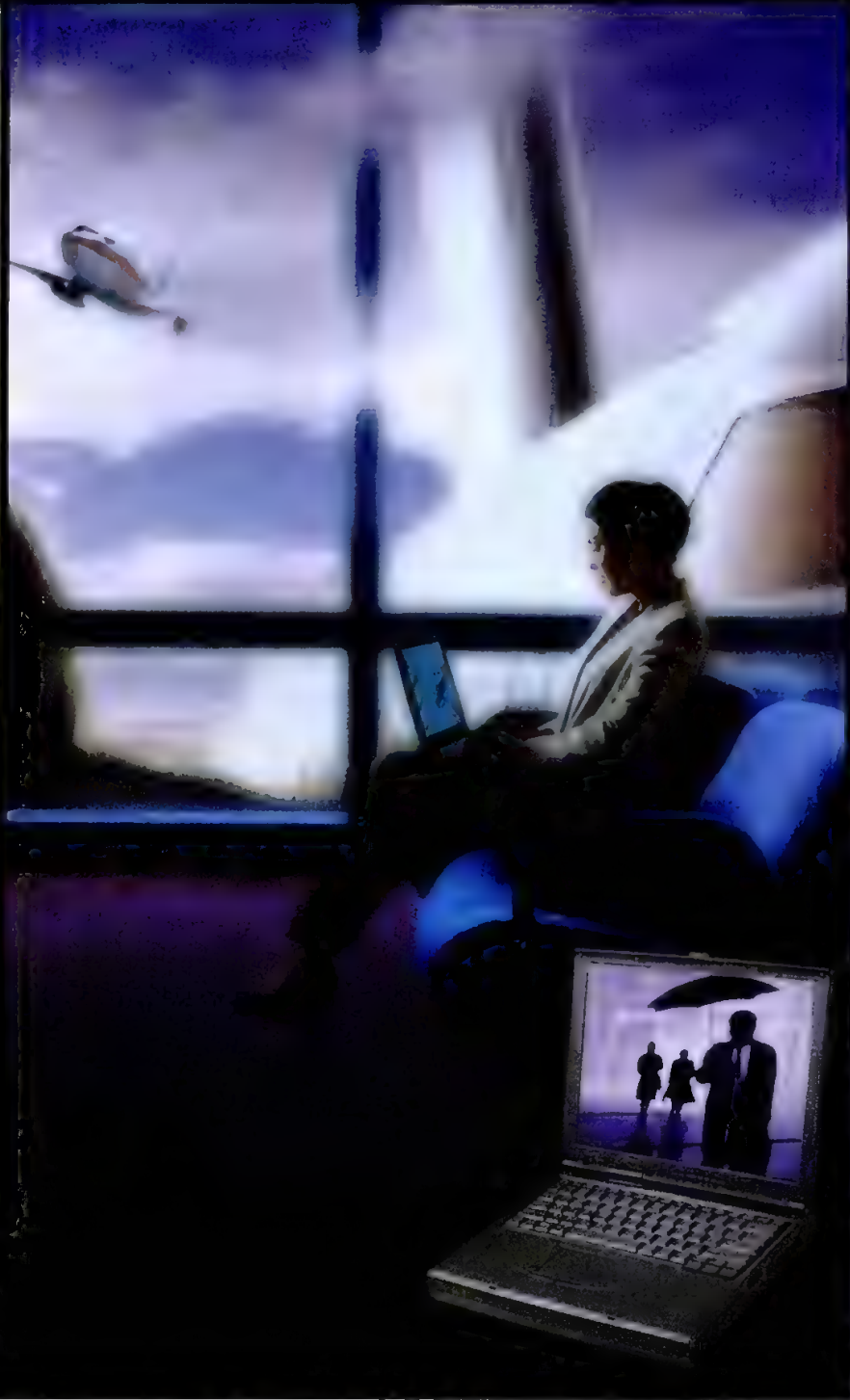
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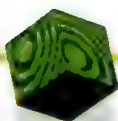
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Most designers accustomed to working in 2-D have mixed feelings about 3-D graphics software. It's easy to see why. On the one hand, there's something appealing about designing objects and scenes that have real depth. On the other hand, 3-D modeling and animation programs traditionally have been expensive and difficult to learn and use, and it seemed as if you needed a Cray supercomputer to run them.

Several trends are helping to remove those barriers and make 3-D more accessible. On the hardware front, faster processors, cheaper RAM, and inexpensive OpenGL graphics cards enable today's sub-\$2,500 desktop PC to outperform yesteryear's Silicon Graphics workstation. Microsoft Window NT's multithreading capabilities are also a big advantage when it comes time to render 3-D projects.

As the hardware has progressed, 3-D software has also improved. For \$600 or less, you can get a 3-D package that includes a full complement of modeling and scene composition tools, is easier to learn, and runs comfortably on a mainstream desktop PC. The operative word here is *easier*. By nature, 3-D is simply more difficult than 2-D (as we discovered during our testing), and these programs can be challenging for first-time 3-D designers. Budget plenty of time for your first several projects. But these packages are ideal for users who are comfortable in professional-level programs such as Adobe Photoshop and want to expand into 3-D to create eye-catching still images, build animations for a presentation, or design virtual-reality scenes for the Web.



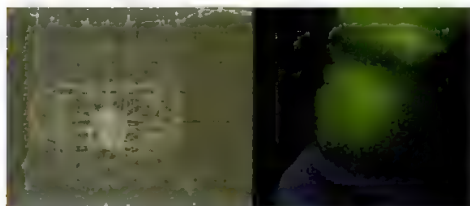
Key 3-D Concepts

Although 3-D software has gotten easier to use, there are still some concepts you'll need to grasp in order to get the most out of these packages.

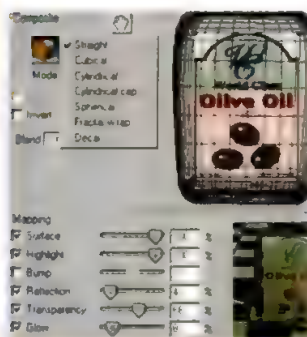
MODELING

The first step in generating 3-D graphics is to create the basic models or shapes that will make up your image. These can be formed from basic objects (known as *primitives*) such as cubes, balls, and cones, or they can be created by hand. We explain some key modeling features below.

NURBS: This odd-sounding feature (short for *nonuniform rational B-splines*) helps you to model meshes, or wireframe representations of a surface, into more organic shapes.



Visual mapping: This type of control lets you accurately apply texture maps to a surface such as a bottle label—a great feature for product mock-ups and similar projects. Here we see Infini-D's visual-mapping controls.



COMPOSITION

Once you've created your models, you need to arrange them in a scene. To do that, you must position the models precisely in 3-D space and add cameras, lighting, and effects. Here are some composition features we especially liked.

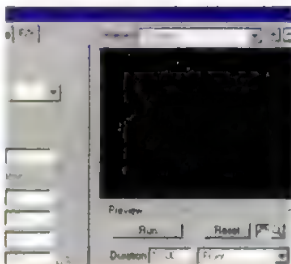
Positioning:

Aligning objects in 3-D can be very time-consuming. We used Ray Dream Studio's numeric orientation controls to shave significant time off our test projects. To make sure a bottle was flat against a desk and standing straight, we entered 0 for pitch and 90 for roll, then lowered

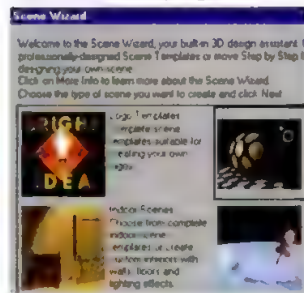


the bottle slowly until Ray Dream's collision detection feature told us we'd hit the desk.

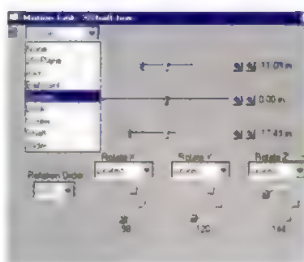
Particle effects: Nearly all programs have particle effects, but they're not all created equal. Look for controls that let you localize each effect. Pictured here are Infini-D's particle effects.



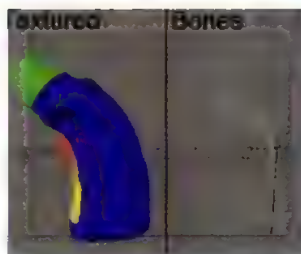
Templates: Though most animation timelines are fairly simple to use, templates like these can save a lot of time on your development schedule, especially when you are just starting out with one of these programs.



Inverse kinematics: This term refers to the relationships between objects in a 3-D model. You use inverse kinematics to define a series of links between parent and child objects. For example, you can create a series of links for an arm that tie the shoulder to the elbow to the fingers, all defined with rotational and movement constraints that mimic the way joints actually move. That way, when you move one finger the rest of the arm reacts accordingly. This example uses Ray Dream Studio, the only tested program that supports inverse kinematics.



Bones: Basically, bones are exactly what you'd expect. Using bones, you can animate an inanimate object by adding an internal skeleton. Here we used Inspire 3-D to add bones to a bleach bottle, so that we could

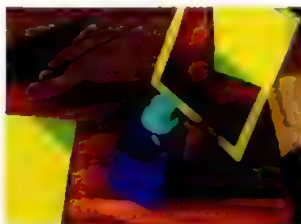


make it take a bow in one of our test animations. Bones are similar to inverse kinematics, except that their basic function is to deform and animate one object; most inverse kinematics schemes animate several combined objects.

RENDERING

The last step in 3-D modeling and animation, rendering in a 3-D application is roughly equivalent to printing in a word processor. But when you're working with 3-D images, the process becomes a little more complicated. These features can help.

Ray tracing: A common rendering method, ray tracing uses hypothetical rays of light from each source to create a more realistic scene than one made by scan-line rendering.



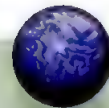
Batch rendering: Even our relatively simple test model took over 4 and a half minutes to render on a 350-MHz Pentium II-based computer. Batch rendering, which renders multiple projects based on a schedule you set, can save a lot of time. Multi-threaded programs are also time-savers.

Four products met our criteria: Byte by Byte Software's SoftF/X Pro 4.1, MetaCreations' Infini-D 4.5 and Ray Dream Studio 5.0, and NewTek's Inspire 3D 1.0. Caligari's trueSpace 4 (\$595 list) did not ship in time for our story, but should be available by the time you read this. These programs occupy a middle ground between basic "titling and effects" tools such as MetaCreations'

LogoMotion and Ulead Systems' Cool 3D, and high-end solutions such as Softimage (now owned by Avid Technologies), Kinetix's 3D Studio MAX, and Alias/Wavefront, which cost thousands of dollars.

Our Contributors: JAN OZER is a contributing editor of *PC Magazine*. DIANE JECKER was the project leader and JOHN MORRIS was the associate editor in charge of this story.

To evaluate 3-D software, we looked at four key areas: modeling, scene composition, animation, and rendering. Modeling features range from primitives to freeform and deformation tools such as NURBS. Desirable scene composi-



tion features include precise positioning controls, collision detection, and robust particle effects, among other effects. To bring your projects to life, most packages support either keyframe or path-based animation (SoftF/X supports both). Only Ray Dream offers inverse kinematics for more easily animating complex sequences such as leg or arm movements. On our performance tests, most products rendered a simple project in about 5 minutes. All four support ray tracing, but some offer additional rendering engines and features such as batch rendering as well.

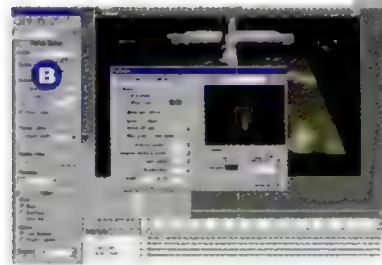
Although 3-D is still not for everyone, experienced users will find that these relatively low-priced packages bring sophisticated modeling and animation to the PC.

Infini-D 4.5

\$600 street. MetaCreations Corp., Carpinteria, CA; 800-472-9025, 408-430-4000; www.metacreations.com; 551 at www.pcmag.com/infolink.

● Targeting video and broadcast professionals, MetaCreations' Infini-D 4.5 offers sophisticated scene-composition tools, such as natural-looking particle effects and extensive lighting options, not found in other programs in this price range. But Infini-D proved difficult to use. For most general 3-D projects, other products in this category will deliver similar results faster and with less hassle.

Infini-D's interface consists of the object palette on the left, an animation controller on the bottom, and four floating windows representing top, front, right, and camera views. For the most part, we found Infini-D's navigational, sizing, and rotational controls clumsy and frustrating, making ordinary activities somewhat complicated. Infini-D also lacks multiple levels of undo, object grouping, and collision detection.



(A) Infini-D uses the standard orthographic, four-window interface for modeling and animation. (B) Infini-D's particle effects are strong, with advanced features such as collision detection, and natural-force behaviors such as wind and gravity.

Editors' Choice

● Ray Dream Studio 5.0



The midrange 3-D packages reviewed here face a tough challenge. On the one hand, they strive to offer the high-end features found in packages that cost

thousands of dollars. On the other, they aim to make 3-D seem approachable to a mainstream audience using PCs. MetaCreations' Ray Dream Studio 5.0 (\$300 street) comes closest to meeting this challenge, earning our Editors' Choice.

Those new to 3-D will probably find Ray Dream's interface easier to use than most 3-D programs. Rather than the traditional orthogonal (four-pane) view, Ray Dream's interface consists of three walls that represent the x, y, and z axes. You can grab objects or their outlines on the wall to resize and move them. We also like having the ability to enter exact values for x, y, and z coordinates, as well as yaw, pitch, and roll, to position objects.

Ray Dream includes a generous set of ready-made models, shaders, and other sample files. To create your own objects, you can use free-form or

mesh tools. Ray Dream includes a good selection of lights and lighting effects, and wizards help you select lighting, background, and props. Effects such as fire, fountain, clouds, and fog can be placed in specific areas within a scene.

Ray Dream was the only product we tested that supports inverse kinematics, a feature that links related objects and specifies how they should move in relation to one another. Other useful animation features include collision detection and behaviors such as rebound.

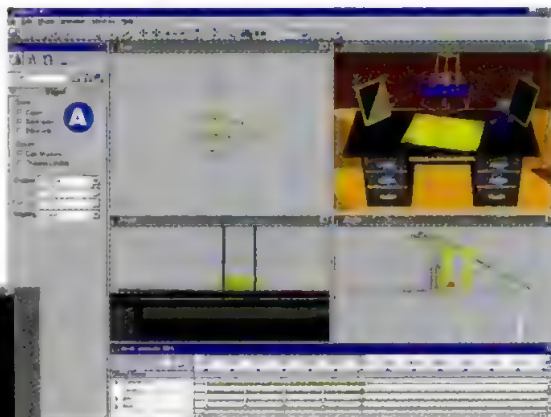
The output options in Ray Dream are extensive. The program offers several different levels of preview, and you can choose to render only select areas of a project. In addition to ray tracing, Ray Dream supports several different types of rendering. Finally, Ray Dream supports batch rendering and multithreading to improve performance.

The program's modeling capabilities, however, are impressive. Infini-D can create seven different classes of objects

(extrude, lathe, particle, primitives, spline form, terrain, and text), each with its own interface and command structure. For example, text extrusion and bevel controls are located in the text dialog box, simplifying text creation.

Recent feature additions include vertex-level editing in Infini-D's SplineForm workshop and a mesh editor. Falling short of the NURBS-type editing offered by other products, Infini-D provides a range of deformations and intuitive tools for selecting, pushing, and pulling vertices. Mesh edits can't be animated—though other deformations in the main editing window can be.

Infini-D comprehends Boolean editing only during rendering, which complicates design. In addition, rendered Boolean effects don't interact correctly with some of Infini-D's more sophisticated particle



PERFORMANCE TESTS

Making a Scene



So many factors go into creating a 3-D scene that it is difficult to measure precisely the quality or performance of 3-D software. Even our relatively simple project entailed a number of decisions at every step of the way, making it impossible to create truly identical projects in each program.

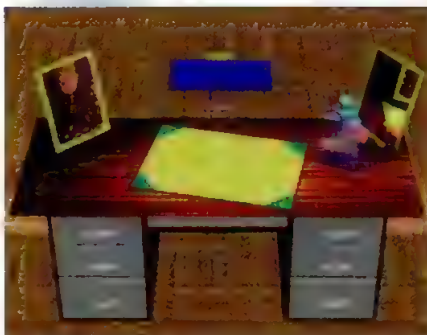
For example, the objects we imported (such as the apple and the bottle) looked realistic when rendered in MetaCreations' Infini-D 4.5 and Byte by Byte Software's SoftF/X Pro 4.1. When we rendered a similar scene in NewTek's Inspire 3D 1.0, the same objects looked like toys. A more skilled user, however, might be able to manipulate textures and lighting better to make the objects look more lifelike. We did see some differences in the anti-aliasing capabilities; here Inspire fared best, generating smooth edges.

We saw little difference in performance when rendering our test scene. All four products completed the rendering process in 5 minutes or less.

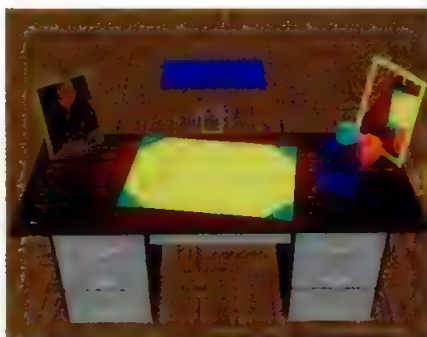
To create the test scene, we imported several DXF (Document eXchange Format) objects from Viewpoint DataLabs' library of 3-D models (www.viewpoint.com). After importing the objects, we sized them and applied colors and textures.

We positioned the objects in the scene to create a good mix of diagonal lines, which often expose aliasing. We also tested each product's ability to create a transparent object, to reflect surfaces from a mirror accurately, and to display correctly a texture bitmap applied to a diagonal surface. Finally, we added two spotlights to illuminate the scene and positioned a camera above the scene at 45 degrees.

We rendered each scene as an 800-by-600, 24-bit image using each product's ray tracing engine with settings such as anti-aliasing and other quality levels adjusted to maximum levels. All testing was performed on a 350-MHz Pentium II-based PC running Microsoft Windows NT 4.0, with 128MB of RAM and a Diamond Fire GL 1000 Pro video card.—Jan Ozer



▲ Infini-D 4.5



▲ Inspire 3D 1.0



▲ Ray Dream Studio 5.0



▲ SoftF/X Pro 4.1

and lighting effects. Therefore, you should avoid Infini-D if your projects involve Boolean objects.

Though Infini-D objects don't have collision detection, particle effects do, so rain will bounce off the chimney and stop when it hits the ground. And despite the animator's lack of support for natural-force behaviors, you can set up particle "warps" that simulate the behaviors of such forces as wind, friction, and gravity.

Like the other products, Infini-D lets you create surfaces from bitmapped images and colors, and from templates for common surfaces. Though there is no 3-D paint facility, Infini-D has an extraordinarily flexible mechanism for creating and applying composed surfaces, such as labels and logos, to your target surface. It's a natural for product mock-ups and similar projects.

Infini-D's lighting capabilities are another strength. Infini-D has tube lights that are useful for simulating florescent lightbulbs or evenly lighting long planes. Lighting effects include visible beams and rays, as well as the most extensive library of editable lens flares in this roundup, providing control over glow, halo, streaks, and lens type. Infini-D also offers many camera types, including fish-eye, macro, and two QuickTime VR lenses.

A keyframe animator, Infini-D has excellent visual spline controls for editing paths between the key frames, or *Event-Marks*. The program can animate cameras, effects, lights, and objects, with the notable exception of changes to mesh objects and certain lighting effects.

The animation sequence window contains all animation-capable objects and their EventMarks. This window can also display a waveform to help synchronize effects with audio. The program includes a number of canned animation "assistants," but they don't always seem to work as advertised. Infini-D supports object linking, so you can group objects and assign rotational and directional constraints, but not true inverse kinematics, to them.

During development, you can configure displays in all four windows from wire-frame views to fully *phong-shaded* models, though the latter slows operation noticeably. (Phong shading is a computation-intensive method of rendering that yields

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realistic-looking objects by smoothing polygons and adding highlights.) Those who work in lower quality modes will appreciate a marquee renderer that enables preview of selected window regions.

Infini-D earns its stripes in the broadcast world with a host of video-related features, including preview-over-video, field rendering in nonsquare pixel format, and NTSC color correction. This version also supports MetaCreations' new plug-in-based Metastream format for streaming 3-D objects over the Web.

Though Infini-D doesn't support multi-threading, its new batch facility is the most sophisticated of the group. Infini-D's ray trace engine produced quality output with realistic objects and textures, though a few more visible jaggies were present than in other products.

If particle effects, lighting, and Quick-Time VR output are important to you, you'll be pleased with Infini-D. For general purpose 3-D work, however, other products deliver similar features in more usable packages.

Inspire 3D 1.0

\$360 street. NewTek, San Antonio; 800-862-7837, 210-370-8001; www.newtek.com; 552 at www.pcmag.com/infolink.

● NewTek's Inspire 3D is the progeny of NewTek's flagship product, LightWave 3D, which is known for its broadcast-quality rendering. Because Inspire's files import directly into LightWave, the product is a natural choice for designers who want to work at home on a desktop PC. But Inspire is a strong product in its own right, with a good selection of objects, comprehensive modeling tools, and a clutter-free workspace, making it a fine choice for a wide variety of 3-D projects.

The interface comprises two separate programs, Modeler and Layout. Both are functional, but each has a separate user interface paradigm and separate controls. Inspire ignores many accepted Windows interface standards, including right-mouse-click commands, online help, and start-up wizards. On the plus side, the program maximizes work space, resists clutter by eschewing floating menu windows, and includes a useful tutorial. And once you're familiar with the layout, you'll waste little time searching for controls.

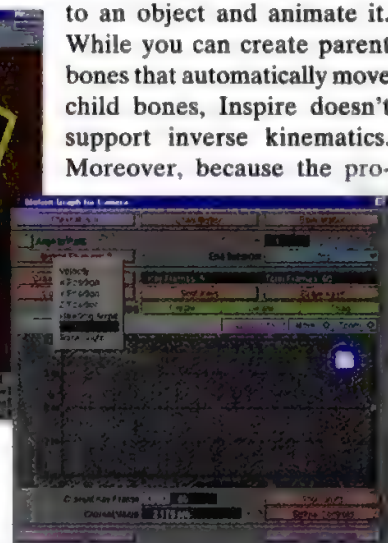
Modeler has three views—top, face,

and side—and a real-time OpenGL-rendered preview window. Besides the standard cone, cube, disk, and sphere, Inspire offers an unparalleled number of primitives, including gears, snails, spline cages, toroids, and wedges.

The standard size, flex, and deformation tools are present, as well as Boolean addition and subtraction and Meta-NURBS, which mold objects into organic



(A) One of Inspire's best features is its uncluttered and logical workspace. (B) When creating animation, Inspire provides extensive control over all keyframe parameters.



shapes with minimal effort. Because they are performed in Modeler, edits to Meta-NURBS can't be animated.

Inspire offers relatively few canned deformations. Furthermore, the Modeler and Layout programs contain different deformations, forcing you to use two different sets of construction tools. Once you've imported an object into Layout, you have to be careful; if you re-edit it in Modeler, you may lose all of the texturing and animation effects.

Inspire's texture capabilities are competent, but some texturing operations are complicated due to limited bitmap application tools. Lighting types are also limited and somewhat clumsy to deploy, with unrealistic effects. For instance, lights became brighter as we widened the angle of a cone. The program does include extensive lens-flare options and the unique ability to view the scene from the light's angle.

The Layout component consists of one large, gridded screen containing an animation controller and menus. Object placement is easy, and the scene manipulation tools are excellent. But there is no collision detection or object grouping, complicating even minor scenewide adjustments.

Inspire is a keyframe animator with spline controls for interkeyframe tension, continuity, and bias, but it lacks visual tools to see their effects. Though you can't draw an animation path, you can view and edit the path and all keyframe values, enabling an extraordinary degree of precision.

Inspire supports dissolves, morphs, and bones, which lets you add a skeleton to an object and animate it. While you can create parent bones that automatically move child bones, Inspire doesn't support inverse kinematics. Moreover, because the pro-

gram doesn't have collision detection or natural-force behaviors such as gravity, animation is almost completely manual. When working in the animator, you can preview an entire frame or marquee selection, but the preview uses Inspire's rendering engine, so it requires more time than the preview functions in other products.

When you're ready to render, you can dress up your scene with a number of effects, including motion blur, animated glows, and shifting fog. But the ability to localize fog was limited.

Like that of most products, Inspire's OpenGL rendering engine got bogged down by complicated scenes, forcing us to display in wireframe mode and hide texture-intensive objects. Inconveniently, rendering options are spread between rendering and camera controls, rather than being located in one place.

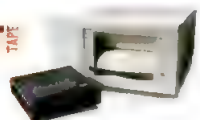
Rendered output quality was very good, with the smoothest anti-aliasing of the group and high-quality textures. But the imported objects, such as our apple and bottle, looked cartoonish. Rendering speed was good; although it lacks batch rendering, Inspire supports multi-



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threading to speed rendering on multi-processor computers.

Inspire 3D inherited the full ray-tracing rendering engine from LightWave 3D, including a CEL shader that offers cartoonlike effects and stereoscopic output. But the maximum supported animation resolution is 640 by 480, making Inspire inappropriate for video output. Inspire does, however, support both VRML 1 and 2.

Although it is missing some of the more advanced features, Inspire is a competent program that is relatively easy to use. But its biggest selling point will continue to be its link with LightWave.

Ray Dream Studio 5.0

\$300 street. MetaCreations Corp., Carpinteria, CA; 800-472-9025, 408-430-4000; www.metacreations.com; 553 at www.pcmag.com/infolink.



Despite a \$300 price tag, MetaCreations' Ray Dream Studio is a powerful program that includes many of the features found in higher-priced packages. Although a handful of its tools were difficult to use, Ray Dream offers the best range of features and innovative tools such as inverse kinematics, making it ideal for all 3-D projects other than just path-based animations.

Ray Dream consists of four main panels: the perspective window, where you build your scene; the properties window, which includes textures, deformers, behaviors, and adjustment controls; the browser window, which contains project objects, textures, behaviors, and other assets; and the animation timeline, which also tracks all objects and effects used in the composition. To reduce screen clutter, the properties and browser windows both use tabbed views.

Ray Dream provides wizaRay Dream to help select lighting, background, and props. There are also many models, shaders, and other sample files on the CD-ROM. But when you can't find the right canned object, Ray Dream provides three modeling mechanisms: geometric primitives, a Free Form Modeler that converts line drawings into 3-D images, and a Mesh Form Modeler.

You can edit individual vertices in the mesh, or use the "sphere of attraction"

tool to move groups of vertices, but these mechanisms are crude compared with the NURBS-type feature offered in other products. To modify an object's shape, you can also use specific *x*, *y*, and *z* values or deformers.

The perspective window displays three walls with configurable grids that represent the *x*, *y*, and *z* axes. Outlines of all objects, cameras, and lights are projected against each wall. To resize and move objects, you can either manipulate the object itself or any of its projections. This is useful for precisely aligning objects.

Though collision detection helps in object placement, Ray Dream's virtual trackball, used to spin and rotate objects, is cumbersome. The properties window, however, provides an easy alternative. The numerical *x*, *y*, and *z*, as well as the yaw, pitch, and roll adjustments, were particularly useful.

Ray Dream's shader editor handles all texture operations, which are generally competent despite the clumsy texture-mapping controls. Ray Dream also offers four volumetric primitives—fire, fountain, clouds, and fog—with superb control over placement, a feature not found in most other programs.

Ray Dream's camera



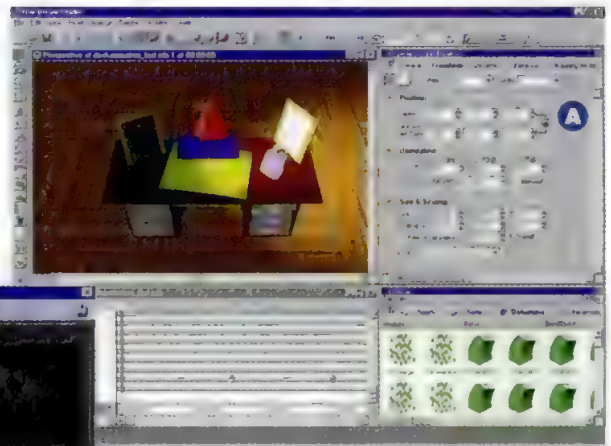
positioning controls are twitchy, complicating precise camera placement. This is exacerbated by rendered output that doesn't match the rendering camera view. We had to perform multiple camera adjustments and renderings to achieve our desired results. One noteworthy feature is the IVRM spherical lens, which creates a panoramic rendering for use with a virtual-reality viewer.

Lighting features are strong, with control over beams, bulbs, distant lights,

moonlight, and spotlights. Each has controls for color, intensity, and effect. You can also apply gels to your lights, toggle shadows on and off, and control how shadows are rendered. The 3D Aura light pack, from RAYfect, provides lighting effects performed during rendering.

Ray Dream is a keyframe animator with an extensive collection of physics-based behaviors, such as friction and rebound. Unlike the other products in this roundup, Ray Dream supports inverse kinematics. Probably its only significant deficit is the inability to create or edit motion paths directly, though you can view them. Ray Dream is also the only program in this roundup that allows an object to point to another object, a huge advantage for some animations.

While creating your projects, you choose between a range of preview quality settings. On our test station, only the highest-quality preview slowed performance; all other previews appeared instantaneously. A "render area" control



(A) Ray Dream's new tabbed interfaces in the properties and browser windows reduce much of the clutter found in previous versions. (B) RAYfect's excellent four-elements module adds realism to Ray Dream's natural landscape models.

lets you draw a box and render any screen area.

When its time to output, Ray Dream provides a nice set of rendering presets, from low-resolution previews to full-size/full-speed output. You can also customize and save your own output settings. Ray Dream supports batch rendering and multithreading.

The second-fastest renderer on our tests, Ray Dream ships with Adaptive, Draft Z-Buffer, Natural-Media, and Ray

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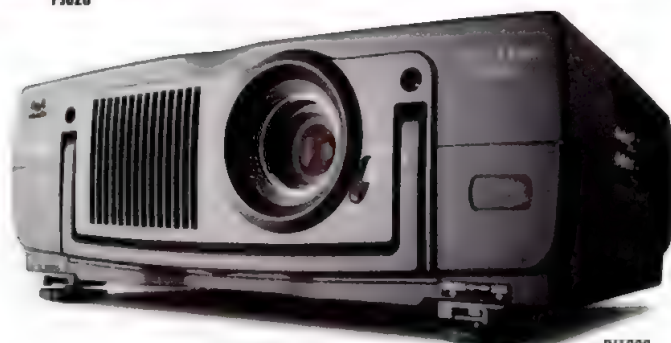
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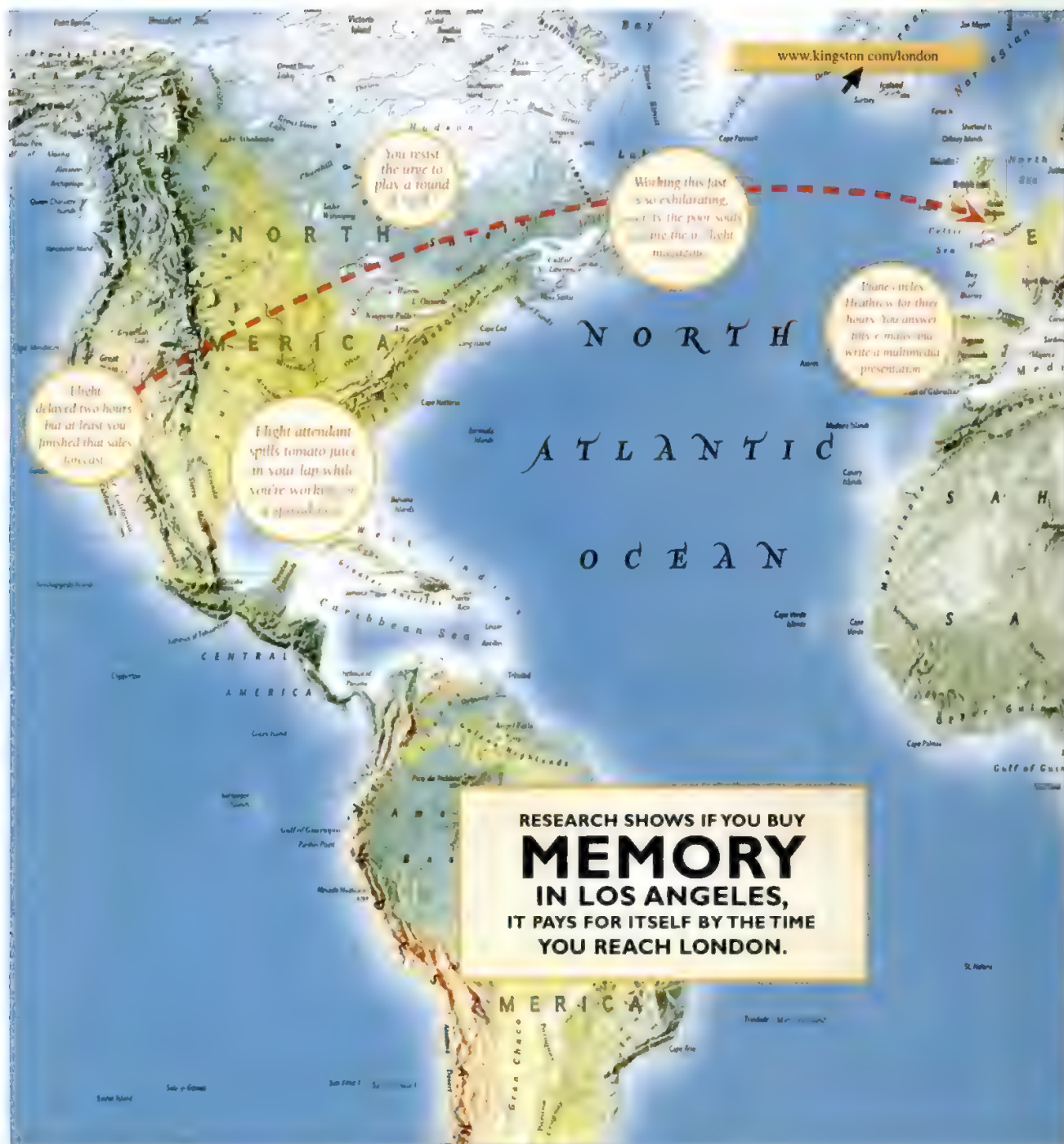
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Suitability To Task

	Infini-D 4.5	Inspire 3D 1.0	Ray Dream Studio 5.0	SoftF/X Pro 4.1
POWER				
Modeling	Good	Good	Good	Good
Scene composition	Excellent	Fair	Good	Good
Animation	Good	Excellent	Good	Good
Preview and rendering	Good	Good	Good	Good
EASE				
Modeling	Poor	Good	Excellent	Good
Scene composition	Fair	Good	Excellent	Good
Animation	Fair	Good	Good	Fair
Preview and rendering	Good	Good	Good	Good

Modeling To perform well on this task, 3-D packages must offer a full range of modeling tools, including a good selection of primitives and the ability to sketch against a template such as an imported bitmapped image. Higher-end tools include NURBS and canned deformers. We also take ease of use into consideration. Tutorials, presets, and wizards are a big advantage. Numeric controls for specifying the size of objects and support for multiple undo and redo are also big pluses.

Scene composition For this task, we evaluate each program's ability to arrange objects in a scene. Important features include the ability to group and ungroup objects easily and enter coordinates to position objects precisely. We also look for a wide selection of lights and cameras that can be controlled easily, and naturalistic particle effects, as well as other effects such as fog

Animation Our animation task reflects each program's ability to create and edit animation paths and keyframes. A number of other features also enter into the mix, including natural-force behaviors such as gravity and collision detection, and tools such as bones and inverse kinematics.

Preview and rendering The preview options vary from program to program. We look for products that offer a marquee, object previews, or key-scene previews, which all save time by eliminating the need to preview the entire project. The packages here support a variety of rendering techniques, including ray tracing, but not all offer field rendering for NTSC output in broadcast applications or specialized rendering engines for QuickTime VR or VRML. Other important features include support for multithreading and batch rendering.

Tracing renderers. The ray-tracing renderer produced very good results, with smooth anti-aliasing and realistic natural textures, whereas the Natural-Media renderer simulates painted output.

Well suited to virtually any user, Ray Dream Studio is a great 3-D program at a great price.

SoftF/X Pro 4.1

\$300 street. Byte by Byte Corp., Austin, TX; 512-256-8810; bytebybyte.com; 554 at www.pcmag.com/infoclink.

● SoftF/X Pro 4.1 has its moments. The program offers controls for precisely positioning objects and handling text, and both keyframe and path-based animation. But it is missing some of the fundamentals. The modeler lacks NURBS or similar tools, lighting selections are sparse, and the rendering options are limited. Furthermore, SoftF/X's reliance on plug-ins makes the program more difficult to use.

Byte by Byte Corp. sells two versions of SoftF/X: the Pro version we tested, and the regular version (\$100 street), which lacks some of the scene-composition and animation tools in the Pro ver-

sion and does not support multithreading. SoftF/X is made up of two main programs: the modeler and the animator. Unlike Inspire 3D, SoftF/X automatically updates changes made to models imported into the animator, improving the convenience of the dual-program approach.

By default, both programs use the traditional orthographic four-window view, with tool panels on the left and menus on top. After learning basic program operation, moving about both programs is very easy, even without collision detection to help with object placement. Unfor-

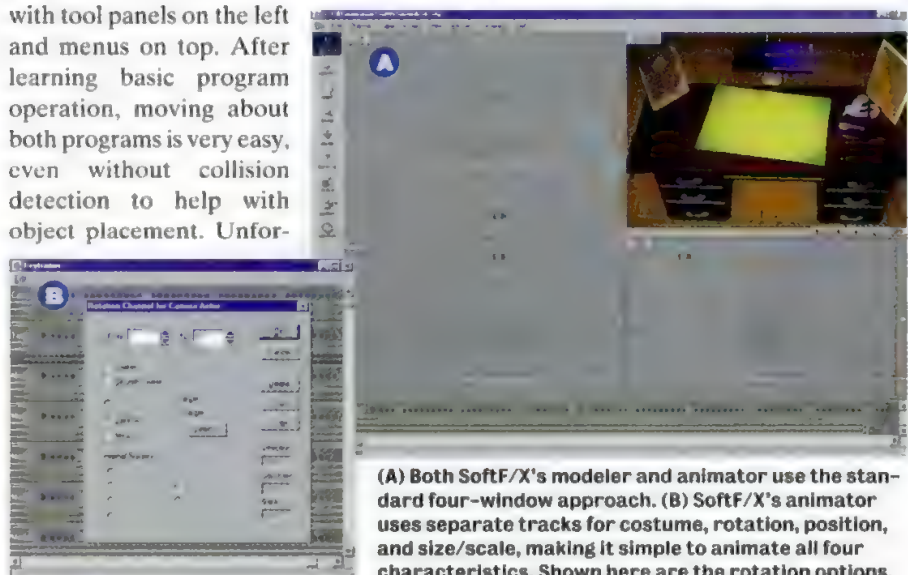
tunately, the undo and redo features work only in some instances.

The modeler's basic object-creation tools are competent, but they lack some of the advanced features for terrain creation found in other products. This is somewhat exacerbated by the lack of NURBS or similar functions, though you can easily manipulate single or multiple vertices.

On the plus side, SoftF/X is one of the few programs that works with both TrueType and PostScript fonts, with simple controls for setting character width, and the angle and depth of front and back bevels. Users seeking precision will also appreciate the ability to set a model scale and specify size and position values for all geometric primitives.

The modeler supports *forward* kinematics, using joints to create a skeletal hierarchy that allows parent objects to move all linked children objects. A Robot Hierarchy tool in the animator provides controls and enhanced preview for posing the robot, with the helpful ability to save and reuse poses. Though SoftF/X's skeletal system gets the job done for simple animations, it is time consuming and somewhat tedious.

Texturing capabilities are mixed. Although the program can simulate natural surfaces, customization is limited, and the preview is clumsy. Texture mapping is more functional. You can resize and tile bitmapped images and apply textures to planes, cylinders, and spheres. But the process you use to apply textures is tedious and far from intuitive. SoftF/X



(A) Both SoftF/X's modeler and animator use the standard four-window approach. (B) SoftF/X's animator uses separate tracks for costume, rotation, position, and size/scale, making it simple to animate all four characteristics. Shown here are the rotation options.





**Infinite
possibilities.**

SUMMARY OF FEATURES

3-D Modeling and Animation

PC MAGAZINE
EDITOR'S CHOICE

■ YES ■ NO □ OPTIONAL

	Infini-D 4.5	Inspire 3D 1.0	Ray Dream Studio 5.0	SoftF/X Pro 4.1
General Features				
Street price	\$600	\$360	\$300	\$300
Wizards (modeling or animation)	■	■	■	■
Quick reference card	■	■	■	■
Right-mouse-click commands	■	■	■	■
Undo/redo (number of levels)	■ ■ (1)	■ ■ □	■ ■ ■ □	■ ■ ■ (2)
Context-sensitive online help	■	■	■	■
Number of objects	> 52	> 400	> 850	30
Number of textures	> 100	> 200	> 629	40
Modeling				
Canned deformers	None	20	94	8
NURBS	■	■ (MetaNURBS)	■	■
Sketch against template	■	■	■	■
Insert object by specifying x, y, and z values	■	■	■	■
Scene Composition				
Collision detection	■	■	■	■ (ground only)
Group selection	■	■	■	■
Hide and reveal objects	■	■	■	■
Positioning controls for pitch, yaw, and roll	■	■	■	■
Lighting				
Types	Ambient, distant, point, spot, target spot, tube	Ambient, distant, point, spot	Ambient, bulb, distant, spot	Ambient, dummy, point, spot, tube
Visible rays	■	■	■	■
Lens flares	■	■	■	■
Textures				
Manually map against target object	■	■	■	■
3-D paint	■	■	■	■
Other Effects				
Specialty terrain object	■	■	■	■
Fog/Clouds/Fire	■ ■ ■	■ ■ ■	■ ■ ■ ■	■ ■ ■ ■
Particle Effects				
Collision detection	■	■	■	■ (ground only)
Natural-force warp capabilities	■	■	■	■ (deformers only)
Animation				
Path or keyframe animation	Keyframe	Keyframe	Keyframe	Both
User can edit path	■	■	■	■
Natural-force behaviors	None	None	6	4
Deformers	10	6	14	10
Dissolve	■	■	■	■
Morphing	■	■	■	■
Parent/child linking	■	■	■	■
Inverse kinematics	■	■	■	■
Preview				
Scene preview (without rendering)	■	■	■	■
Marquee preview	■	■	■	■
Object preview	■	■	■	■
Rendering				
Ray trace engine	■	■	■	■
VRML/QuickTime VR/MetaStream	■ ■ ■	■ ■ ■	■ ■ ■	■ ■ ■
Field rendering	■	■	■	■
Other special rendering engines	QuickDraw	None	Natural Media	None
Batch rendering	■	■	■	■
Supports multithreading	■	■	■	■

offers two techniques for animating texture changes, however; a high-level feature typically not found in products in this category.

SoftF/X's core lighting selection is relatively small, and the controls for positioning and setting parameters are crude. Plug-ins for lens flare, halo, laser, and glow augment these basic features, but even these have limited visual configuration tools. In SoftF/X, lights and cameras can both be animated and pointed at objects or targets. The base camera features are sparse, with no special-purpose lenses. To modify the cameras, you must use a separate plug-in.

The scene creation tools also include sky and ground objects, and atmospheric effects such as snow, fog, and rain. Sky objects can be plain or graded color images, or animations. Ground objects can be any color, a simulated surface, or tiled or single-image map. Unfortunately, you can't localize effects within a scene.

SoftF/X supports both path and keyframe animations, with four tracks (costume, position, rotation, and size scale) maintained in the Keyframer animation controller. The program ships with a number of animation effects.

Animation paths are either drawn with a pen tool or created using geometric primitives, aligning objects to the path in the Keyframer. Once aligned, the separate tracks make it simple to animate parameters such as speed and rotation. You can import canned deformers such as wave, twist, and explode.

Like most other programs, SoftF/X became bogged down when we opened too many objects and surfaces. Preview functions are strong, however, with real-time wireframe animation previews and one-key OpenGL scene previews.

Output quality was high across the board, with realistic objects, good texture quality, and minimal aliasing. But rendering options are limited; the program lacks field rendering, making SoftF/X inappropriate for broadcast video. Rendering times were relatively slow, but not significantly behind the leaders.

Once you've got a handle on it, SoftF/X is not especially difficult to use. But it doesn't match the features in other products reviewed here, so you'll be better off looking elsewhere. **PC**

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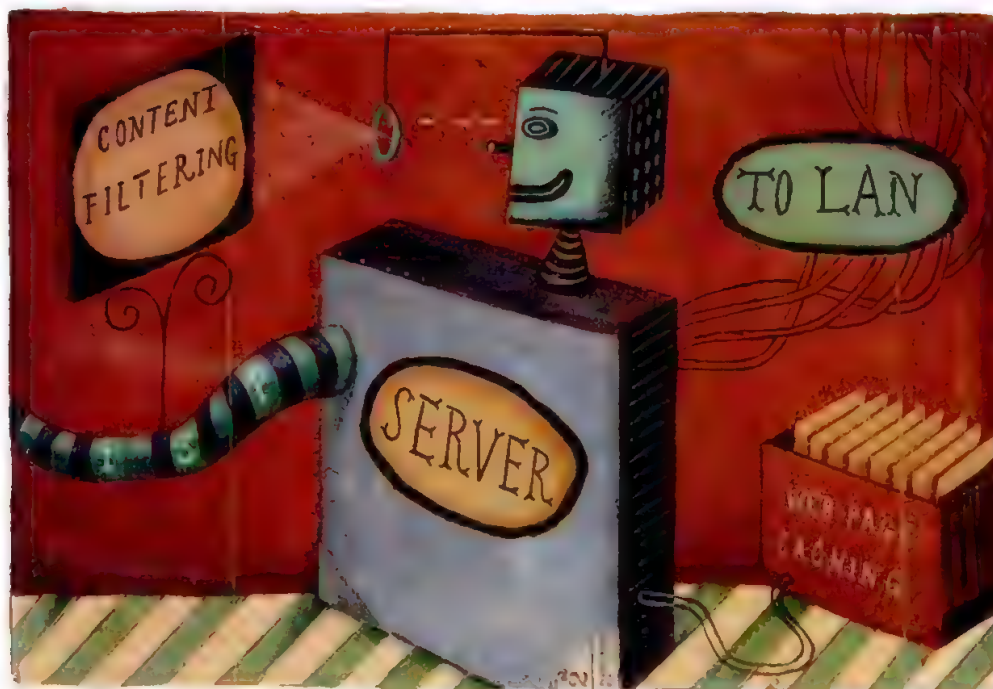
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Net Tools



Fast Pages

For businesses that rely on Web surfing, a proxy server can speed access, provide security, and let users share connections.

By Les Freed

For countless business users, the Web browser is a mission-critical productivity tool that's rivaled only by the telephone. Unfortunately, accessing and navigating the sites you need is often an exercise in frustration and wasted time. Even with a fast connection such as a T1, there's no way to control the connection beyond your LAN or the efficiency of the Web server you're hitting; you'll still find yourself tapping the desk, waiting for an important page to load.

But there is a way to speed Web surfing, as well

as to cut connection costs and even improve security—adding a Web caching proxy server. These applications reside on a server and control all outbound traffic sent from your client PCs. When your users point their browsers to a Web site, they're in essence connecting to the proxy server, which sends the page requests to the Internet. And each time a user requests a Web page, the proxy server caches that page onto its local disk. So the next time the page is requested, the page loads almost instantaneously from cache, speeding performance and saving the proxy from

INSIDE

SMALL INVESTMENT, BIG

PAYBACK: Proxy servers are inexpensive software programs that speed Web surfing and let you share and even combine Internet connections. Contributing editors Les Freed and Steve Rigney put five packages to the test.

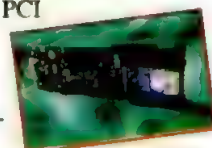
WIRELESS STANDARD:

Contributing editor Bruce Brown tests Bay Networks BayStack 660 Wireless LAN, one of the first 802.11-compliant wireless LAN (WLAN) products *Page 275.*



A NEW BREED OF HUB: Can't afford a switch? Consider an auto-sensing 10/100 hub. ZD Labs' staffers put devices from D-Link, Intel, Linksys, and NetGear to the test. *Page 275.*

SERVER CONTROL: ZD Labs Technical Director Jeff Witt tests the Intel LanDesk Server Manager Pro, a PCI card/software combo that provides network server status and troubleshooting. *Page 276.*



MOBILE MONITOR: Need to manage laptops? Find out from Rigney if Callisto Orbiter 2.0 is up to the challenge. *Page 277.*

PRINT SERVER IN THE CLOSET:

Rigney tests the ExtendNet 100zx, designed to live in the wiring closet and control printers 100 feet away. *Page 277.*

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NetTools Online
All files mentioned in this section are available for downloading from our Web site.

Net Tools

PROXY SERVERS

having to get the page off the Internet.

We tested five proxy servers: Microsoft Proxy Server 2.0, Midcore's MidPoint Gateway 3.1, Netscape Proxy Server 3.5, WinGate Pro 2.1, and WinProxy 2.1f. All work in any size network, but Microsoft's and Netscape's are best suited to midsize businesses. Microsoft Proxy runs on Windows NT Server only; the Netscape server is available for both Windows NT and Unix. The other three products run on Windows 95/98 and provide features more appropriate for smaller installations.

The packages we tested range in list price from \$299 per server (for WinProxy) to \$1,199 for 50 users (MidPoint Gateway). For getting your feet wet, MidPoint Gateway, WinGate, and WinProxy also offer two- or three-user editions and free trial versions.

Because the applications don't hog system resources, you can run them on an existing file server. But if security is a concern, play it safe and use a dedicated system.

THE INCREDIBLE PROXY SERVER

Generally, we found the page-caching capabilities of these products impressive. They all

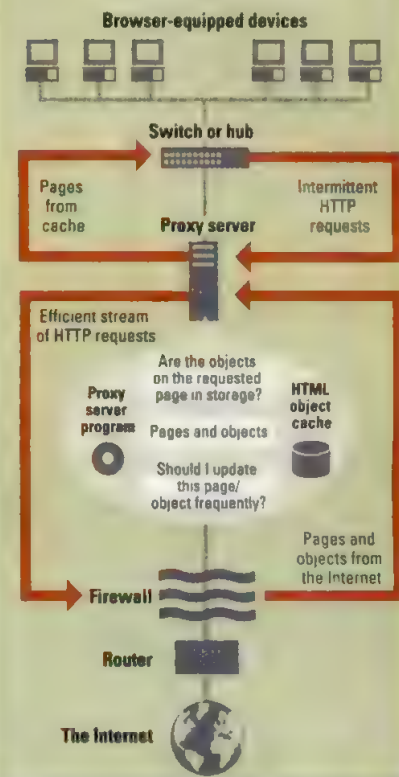
cache HTTP pages automatically, and several cache DNS and FTP requests. You simply configure the maximum amount of disk space

devoted to the cache and the length of time the pages should remain there. To keep the pages fresh, the servers update the pages automatically, based on a *time to live* (TTL) you set by page or globally. Notably, Netscape's server lets you use a last-modified multiplier to calculate how often a page should be updated, based on how often it has been typically updated in the past. And MidPoint Gateway (our Editors' Choice) and WinProxy will let you schedule the caching of specific pages. You can cache specific pages early in the day, so they're available when users arrive. This also reduces the workday burden on the Internet.

Page caching is just one of the proxy server's many talents; it can also do the work of a router and a firewall. Proxies provide routing capabilities by letting you distribute one Internet connection (and ISP account) among multiple network users. And because proxies are simultaneously caching pages, your users will experience accelerated performance

How a Proxy Server Works

A proxy server responds to an uneven stream of user page requests by providing cached pages. It uses algorithms to create a steady stream of HTTP requests.



even as the number of users sharing one connection increases. Our tests bore this out; with 28 clients simultaneously surfing over a 128-Kbps ISDN line, we saw twice the performance of our nonproxy, single-user baseline connection. (The catch, of course, is that proxies accelerate performance only for cached Web pages.) But MidPoint Gateway and WinGate Pro also provide impressive connection-aggregation features that accelerate performance for *all* Internet services. MidPoint Gateway lets you connect up to eight modems and ISDN adapters (across the LAN) using Windows NT, whereas WinGate Pro lets you aggregate connections of all types.

In the simplest sense, a proxy server is a firewall, too—which is to say that it protects the network from intruders. Because the proxy server is the only machine directly connected to the Internet, it serves as a barrier between the clients and the outside world. But firewalls still have their place: Proxies are much less flexible in controlling the data they pass through. Most proxies examine network traffic at the application level

EDITORS' CHOICE

• MidPoint Gateway 3.1



The claims for Web-caching proxy servers sound right out of a late-night infomercial: "Double your browsing speed!" "The more you surf, the more you save!"

The reality is, these products deliver what they claim. Each package we tested is full of useful features and functionality that make it a worthy choice, but Midcore's MidPoint Gateway 3.1 (50 users, \$1,199 list) goes beyond the competition by offering unique features devoted to accelerating performance.

Modem Teaming lets you combine the throughput from up to eight modems on Windows NT, using modems from all over the LAN. Download Doubler speeds downloads by transmitting the files in separate chunks, and Performance Tuner tweaks the registry settings to optimize port settings. Other notable MidPoint features include a wizards-based setup utility that automatically reconfigures clients' browsers and a prefetch feature that lets you schedule

page caching for off-hours. You'll have to pay a premium for all these features, however; MidPoint is the most expensive product we tested.

WinGate Pro 2.1 (\$700 list per server) earns an honorable mention. Its unique features let you aggregate links from any type of connection and even reserve a link for a particular protocol or protocols, such as POP3—ensuring that there's always enough bandwidth for your e-mail.

Microsoft Proxy Server 2.0 and Netscape Proxy Server 3.5 are both well-priced products with features that best suit larger organizations. Microsoft provides a complete set of Internet client services and excellent security with its Dynamic Packet Filtering technique. Netscape Proxy Server provides intensive configuration control and the most robust caching configuration.

CONTENT-FILTERING PLUG-INS

What Site Is That?

The proxy servers in our main story do a good job of controlling which protocols and applications your users can access on the Internet. But most of them offer little or no help controlling which HTML pages and URLs your users can view. For this, consider *content-filtering plug-ins* (or add-ons), software packages built to work with specific proxy-server software. They provide detailed, customizable lists of sites that you can ban users or groups from visiting, as well as increased control over user access—for example, the ability to permit users Internet access during specified times of day.

We tested two popular products, The Learning Company's Cyber Patrol Proxy (100 users, \$1,395 list) and SurfWatch Software's SurfWatch Professional Edition (50 users, \$995 list). We found both straightforward to set up and configure; SurfWatch uses a browser, whereas Cyber Patrol relies on a Windows-based utility. Both products work with the Microsoft and Netscape

proxy servers only; we especially liked the way SurfWatch integrates with them. For setting up filters and access rights, Cyber Patrol uses the utility, and SurfWatch becomes a hot link within your standard browser setup utility, a simpler arrangement that we preferred.

Though the products are comparable in more ways than not, there is a major difference in configurability: Cyber Patrol limits you to 10 user profiles, though they can be used on all clients, whereas SurfWatch lets you set up an unlimited number of users and groups. Both let you list which sites a user can access, and you can specify a time period during the day when the lists can be overridden. For example, you may let users read the news during lunch.

Each of these products includes built-in lists with hundreds of thousands of URLs broken down by category. Cyber Patrol's list, CyberNOT, is used by large ISPs (including AOL) as an option for subscribers

and is composed of 12 different categories. Though you can't add a category, you can add, delete, or modify existing sites in them. Aside from objectionable material, it also includes a list of sports and entertainment sites. In contrast, SurfWatch includes 5 core categories, plus 15 more designed to block hobby, gaming, and chat sites. As with Cyber Patrol, you can add sites and turn off blocking on any particular category. Cyber Patrol updates its URL lists weekly, and SurfWatch does so daily.

Cyber Patrol relies entirely on the proxy server to provide detailed logging information and reports, whereas SurfWatch provides a basic log for discovering whether users have tried to access blocked sites. Fortunately, proxy servers provide detailed usage reports. In addition to the proxy add-on, both vendors provide a content-filtering utility for a handful of popular firewall products. (The Learning Company, Cambridge, MA; 800-227-5609, 617-494-1200; www.learningco.com, 622 at www.pcmag.com/infolink. SurfWatch Software Inc., a division of Spyglass Inc., Los Altos, CA; 800-458-6600, 650-948-9500; www.surfwatch.com, 623 at www.pcmag.com/infolink.)—SR

(FTP, HTTP) and can't examine IP packets. Yet Microsoft Proxy and Novell's BorderManager (see "Proxy Serving, Novell-Style" for details) are exceptions and are marketed as full-fledged firewalls.

PROMISE/REALITY?

As you can imagine, configuring a proxy server is a complex operation. You need to install the software on the server, reconfigure the

clients' browsers to point to the proxy server, set the TTL by page or groups of pages, and configure which clients have access to what protocols, URLs, and so on. As a rule, the more complex products (such as Microsoft's and Netscape's) proved to be the toughest to set up, but they also offer the richest configuration control.

Client-configuration routines varied. MidPoint Gateway's clever utility let us re-

configure all the browsers in seconds, whereas to gain its full functionality Microsoft Proxy required us to install a client driver on each PC and then reboot—tasks totaling about 5 minutes per client. The others required a manual client install that involved opening the browser's configuration-settings window, selecting the "connect through a proxy server" box, and providing the IP address. Netscape will automatically update any Netscape browser.

All the products provide tight control over users and protocols. Though most let you control user access by name and password, MidPoint Gateway lets you control it by PC. WinGate Pro lets you restrict user access by time of day, protocol type, and IP address. Netscape Proxy and WinProxy let you block specific URLs by users or groups. For extra-strength content filtering, look to the Microsoft and Netscape servers, which support content-filtering plug-ins.

The products provide a range of management features, such as a DHCP server, which automatically configures your clients' IP addresses, saving a trip to the machine. MidPoint Gateway also has a DNS server, which adds name look-up services. They all provide logging features, and MidPoint Gateway and WinProxy have real-time activity monitoring.

Suitability to Task

	Microsoft Proxy Server 2.0	MidPoint Gateway 3.1	Netscape Proxy Server 3.5	WinGate Pro 2.1	WinProxy 2.1f
Installation	Good	Excellent	Excellent	Good	Good
Configuration	Good	Excellent	Fair	Excellent	Excellent
Reporting	Excellent	Good	Good	Good	Good

Proxy server software is appropriate for networks of any size. For this story, we focus on the benefits it brings to users in small to midsize businesses in particular, to whom ease of use is most important. To evaluate the products' **installation**, we look at documentation and setup procedures. We prefer wizard-based installation, but packages that provide quick, intuitive installations also score well on this task.

For **configuration**, we evaluate both the power and ease of postinstallation administrative tasks. The ability to customize a package to suit your network needs is of prime

importance, but the ease of performing those tasks is still worth considering. To gauge configurability, we judge the ease of clearing and resizing the cache, adding or blocking protocols, and managing users and sites.

A key to successful proxy server administration comes from the feedback received once the product is operational. Under **reporting**, we evaluate the depth of information that can be accessed, such as which protocols are in use and by whom, how much traffic a protocol is consuming, and which sites users are accessing. We also look for the ability to generate easy-to-read, graphical reports.

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Smart Reseller, August 17, 1998

"Snap! Server offers a quick, convenient fix for stressed-out file servers."

Small Business Computing & Communications,
Hardware Pick: Snap! Server, August 20, 1998

"It installs quickly, is easy to use, and is painless to administer."

Infoworld, Snap! Server Simplifies
Small-Network Storage Chores,
May 25, 1998

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Project Coordinator, Frega Associates Ltd
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Nation's Business, A Network Storage Product that's
true to its name, June 25, 1998



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All but WinGate Pro provide analysis tools to track activity trends. In addition, Microsoft Proxy, Netscape Proxy Server, and WinGate Pro support the CARP and ICP protocols, letting you create a proxy-server hierarchy.

It's important to note that most of these products don't provide each client PC with a complete set of Internet protocols. (The exception is Microsoft, which provides a full Winsock server.) Older versions of Internet applications such as AOL and ICQ might not work behind every proxy server. Newer versions comply with the Socks 5 protocol, providing an application-to-proxy communications standard that lets proxies pass applications like Real Audio. All the products here but WinGate are Socks 5-compliant. Turn to the reviews to see which proxy server best matches your LAN needs.

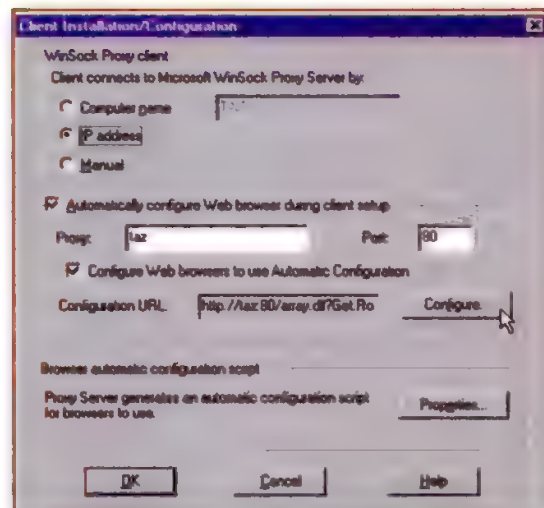
Microsoft Proxy Server

Unlimited users, \$995 list per server. Microsoft Corp., Redmond, WA; 888-215-7484, 206-882-8080; www.microsoft.com. 617 at www.pcmag.com/infolink.

● There's much more to Microsoft Proxy Server 2.0 than its name implies. This Windows NT 4.0 program stands apart from the competition with the inclusion of a full Winsock client replacement, robust firewalling, and ODBC- and SQL-based logging. Microsoft Proxy is best suited to large sites with hundreds of users; small companies that don't need detailed configuration, monitoring, or security should consider a Windows 95 or 98 server such as MidPoint Gateway or WinGate Pro.

As a member of Microsoft's BackOffice family, Microsoft Proxy requires Windows NT Server 4.0 with Service Pack 3.0, plus Remote Access Service (RAS) if you're using a dial-up connection. The program runs as three distinct servers: a caching proxy server for Web access, a Socks server for Socks-compliant Internet applications, and a Winsock server that

when the user initiates a program requiring it. A real-time security alert notifies the system administrator of network attacks, and excellent logging and reporting capabilities track all proxy activity.



IF YOUR CLIENTS already have IP installed, Microsoft Proxy Server 2.0 can automatically configure their browsers after setup.

provides a full suite of Internet services.

Microsoft Proxy's firewall capabilities are more akin to those of Novell's BorderManager than to those of other products here.

The program uses the proprietary technique Dynamic Packet Filtering, which passes a specific protocol through the firewall only when the user initiates a program requiring it. A real-time security alert notifies the system administrator of network attacks, and excellent logging and reporting capabilities track all proxy activity.

We found Microsoft Proxy's 20-minute installation fairly easy for such a complex product. The setup program created a shared directory with the client-software installation files. The client-software component is optional; if the PC is already running TCP/IP and will use the proxy server for Web access only (not for e-mail or other applications), it's unnecessary. But if the PC is running IPX or requires the Winsock server component, you'll need to install it.

The client software also installed easily, adding an applet to the Control Panel and replacing the standard Winsock driver with a Winsock server. One drawback: The Winsock proxy server disables Windows 95's Dial-Up Networking. But you can toggle back and forth by deactivating the Winsock server from the applet, thereby automatically reactivating DUN.

Microsoft IIS users will find management

ALTERNATIVE SOLUTIONS

Proxy Serving, Novell Style

When considering Internet security products—whether they're proxy servers, firewalls, or VPNs—you just can't ignore the power and features of Novell's **BorderManager**. It's built on NetWare and requires a thorough knowledge of the OS. But a set of features that includes firewall, application proxy, NAT, IPX gateway, content-filtering, and VPN capabilities makes BorderManager a viable solution for non-NetWare installations, too. This product (25 users, \$3,995 list; 5 users, \$995) is more expensive and provides a richer set of features than the products in our main story.

Likewise, Novell's standalone proxy solution, **BorderManager FastCache**, is a content-caching utility that's part of the

BorderManager suite and also sold as a standalone proxy server (unlimited users, \$995 list). FastCache requires NetWare, and unlike most of the other proxy servers we tested, it lacks the ability to set filters, control user access, or create reports. You'll find those features in BorderManager, however.

FastCache was designed to compete with high-end hardware caching solutions, such as the CacheFlow 100 Internet appliance (\$8,900 list). But because FastCache can run on a low-end single Pentium processor, it provides the same features as these appliances at a lower cost.

Based on the Squid technology developed by the National Laboratory for Ap-

plied Network Research (<http://squid.nlanr.net>), the product uses Internet object caching similar to Squid's to keep a copy of all recent HTTP objects on a local server. This speeds up retrieval time. And FastCache supports the ICP protocol, which lets you connect multiple proxy servers together. When a user requests an object, ICP will try all of the locally connected proxy servers before it retrieves the page from the slower Internet connection.

In addition to caching HTTP objects, FastCache includes Novell's IPX-to-IP gateway to make your Internet connection more secure. It lets you use IPX on all your local PCs and servers yet still communicate across the Internet. Because the Internet community relies on IP, potential hackers won't be able to see your internal servers that are running IPX. (Novell Inc., Orem, UT; 800-638-9273, 801-222-6000; www.novell.com. 625 at www.pcmag.com/infolink.)

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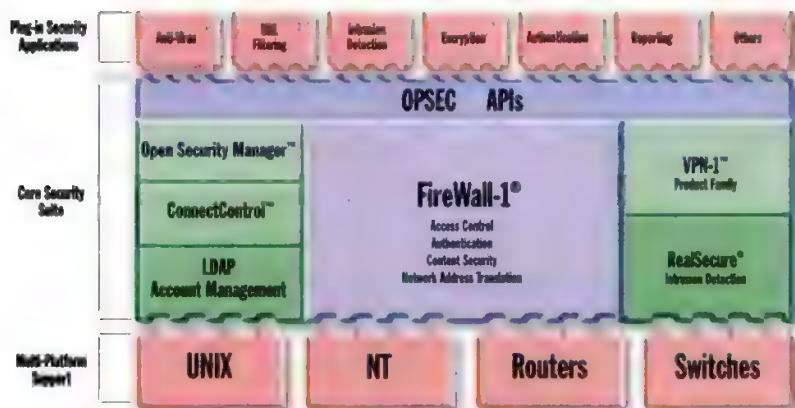
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familiar; Microsoft Proxy uses the same Management Console interface, appearing as separately managed Web, Winsock, and Socks servers. The administration interface is complicated compared with those of other products here, but it provides tight control over user access, authentication, and protocols. For example, you can allow or disallow access

based on user name or IP address, and you can create a separate set of user permissions for each protocol.

Detailed configuration of page-caching parameters lets you specify that pages from a particular domain are always or never cached and specify times certain pages are cached. Microsoft Proxy also works with popular Internet content-filtering plug-in programs, making it easy to control which URLs your users can access.

If security and control are your top management issues, then Microsoft Proxy Server 2.0 is definitely worth considering.—LF

MidPoint Gateway

50 users, \$1,199 list. MidCore Software, Middlebury, CT; 203-577-5370; www.midcore.com. 618 at www.pcmag.com/infolink.



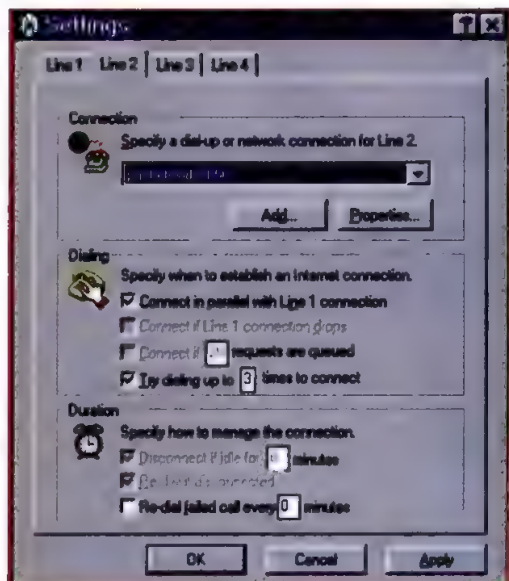
A raft of innovative features sets the pace for this product category and easily earns MidPoint Gateway 3.1 an Editors' Choice. Most notably, MidCore's proprietary Modem Teaming technique can combine the throughput from up to eight

modems or ISDN adapters (residing on one or more systems) to provide near-T1 speeds. Download Doubler increases file-down-

load speeds by splitting files and transmitting the parts separately, and FailSafe Downloads increases reliability by reestablishing lost connections and picking up downloads where they've left off. MidPoint Gateway is the most expensive product we tested, however.

The program works with Windows 95, 98, and NT 4.0. Like WinProxy, it provides an intuitive, wizards-based installation that walked us through the server setup, offering helpful advice along the way. A unique program called Performance Tuner adjusts some registry settings to optimize the serial-port and TCP/IP Dial-Up Networking settings automatically, ensuring top performance. The client-configuration program, Guest Setup, automatically locates and configures the browsers running on the client PCs and lets users configure their settings.

Management functions are performed via a simple, well-organized dialog box. It provides troubleshooting tools as well as real-time activity monitoring that shows a bar graph of the current throughput speed. MidPoint Gateway is the only product here to provide both a DHCP server (which dynamically assigns IP addresses to the clients) and



MIDPOINT GATEWAY 3.1 lets you configure dial-on-demand globally or for specific user groups.

SUMMARY OF FEATURES

Proxy Servers



	Microsoft Proxy Server 2.0	MidPoint Gateway 3.1	Netscape Proxy Server 3.5	WinGate Pro 2.1	WinProxy 2.1f
■ YES ■ NO					
List price	Unlimited users, \$995	50 users, \$1,199	100 users, \$495	Unlimited users, \$700	Unlimited users, \$299
Operating systems supported	Windows NT Server 4.0	Windows 95, 98, NT 4.0	Windows NT Server, NT Workstation, AIX, DEC, HP-UX, SGI, Solaris	Windows 95, 98, NT 3.51, NT 4.0	Windows 95, 98, NT Server, NT Workstation
Maximum number of users	Unlimited	250	Unlimited	Unlimited	Unlimited
Minimum recommended hardware	486-based PC or better, 24MB RAM, 125MB hard disk space	486-based PC or better, 16MB RAM, 10MB hard disk space	486-based PC or better, 32MB RAM, 100MB hard disk space	486-based PC or better, 32MB RAM, 100MB hard disk space	486-based PC or better, 16MB RAM, 10MB hard disk space
Caching methodologies supported	CARP	HTTP 1.1, Proprietary	CARP, ICP	Proprietary	Proprietary
Requires no client software	■	■	■	■	■
Security					
User authentication	■	■	■	■	■
Authentication protocols	Windows NT ACL	MS Networking or proprietary	LDAP	Proprietary	N/A
Content filtering	■	■	■	■	■
Internet filtering plug-ins allowed	■	■	■	■	■
External security	■	■	■	■	■
Certificate authentication	■	■	■	■	■
Client Services and Logging					
Provides DHCP	■	■	■	■	■
Internet file types cacheable	FTP, HTTP	DNS, FTP, HTTP	FTP, Gopher, HTTP	HTTP	DNS, HTTP
User tracking ability	■	■	■	■	■
Analysis tools for logging	■	■	■	■	■
Cache DNS requests	■	■	■	■	■

N/A—Not applicable: The product does not have this feature.

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a DNS server, which provides Internet name look-up services. MidPoint Gateway's user access is based on PC—not on user name and password, as with the other products we tested (with the exception of Microsoft Proxy). This lets you automatically grant access to any system using a DHCP-provided address, reducing administrative overhead without compromising security.

MidPoint Gateway lets you aggregate up to three modems easily on Windows 95 and 98 systems and up to eight modems on Windows NT systems. The MidPoint Satellite program even lets you use modems attached to PCs scattered across the LAN. As Internet traffic increases beyond a user-defined threshold, MidPoint Satel-

lite automatically activates more dial-up connections to increase bandwidth.

As with WinProxy, you can configure MidPoint Gateway's caching HTTP server to fetch Web pages automatically from a predefined list. This lets you update specific pages in the cache before users request them. The limited number of options makes page-caching configuration simple. A basic default setting instructs the cache to refresh pages after a time period you specify.

There's also a two-user version called MidPoint Companion (\$119 list), which provides the same feature set as MidPoint Gate-

Net Tools

PROXY SERVERS

way. Trial versions of the products are available from the company's Web site.

Superb features and performance make MidPoint

Gateway the best choice for any small or mid-size office.—*LF*

Netscape Proxy Server

100 users, \$495 list. Netscape Communications Corp., Mountain View, CA; 650-937-2555; <http://home.netscape.com>. 619 at www.pcmag.com/infolink.

● A member of the SuiteSpot family, the latest version of Netscape Proxy Server supports both Windows NT and Unix servers,

PERFORMANCE TESTS

Proxy Servers



Putting a proxy server between your Web clients and the Internet seems to do the impossible: It lets you share one connection while speeding users' access to Web pages—in essence transforming a low-speed connection into a much faster one.

If your network users spend much of the workday surfing the Web, adding a proxy server will substantially increase the performance of slow Internet connections (such as those made with 56K modems or 128K ISDN), as our tests showed.

We set out to discover what kind of performance a 28-client office could expect using a proxy server to share a single 128-Kbps ISDN connection. For our **Throughput** tests, we evaluated how quickly clients accessed Web pages from a 60MB file set residing on our Web server. We used a 128-Kbps ISDN connection as a reference and initiated the tests with an empty cache. You'll see from the numbers that in most cases, single-client requests mirrored the reference run—a result showing that the files were delivered to the clients over the ISDN link, not from the cache. As multiple clients began making requests, the requested pages were stored in the cache.

As expected, as the number of files that were cached and retrieved increased, so did the products' throughput speeds. Performance gains at the 28-user mark were impressive across all the products—ranging from a 130 percent boost (to 269 Kbps) from MidPoint Gateway 3.1 (our Editors' Choice) to a 59 percent increase (to 185 Kbps) from Microsoft Proxy Server 2.0. To track how the products handled the client load as it increased, we had 1 client request data from the Web server, via the proxy server, for 5 minutes and then increased the number of clients to 4, and so on, until all 28 clients were simultaneously requesting pages. As the number of clients increased, so did the pages in the cache, and thus clients were more likely to request pages already cached.

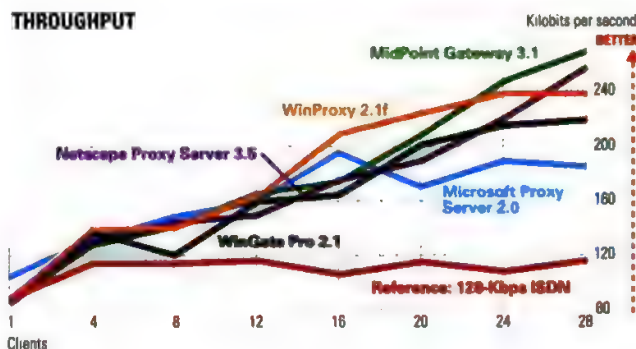
When all 28 clients were making requests, the products had cached about 30MB of the Web files, so about 50 percent of requests were for cached pages. In the real world, the cache-to-hit

ratio (the number of first-time page requests using the Internet connection compared to the number of repeat-page requests filled by the cache) will vary depending on the Web traffic profile of your network; a ratio of 50 percent, however, is not uncommon. The major factor driving the performance of these products—especially with a slower type of link, such as ISDN—is the number of page requests that are filled by the proxy's cache. Our advice: Ensure that the cache size you set doesn't limit the number of requests that the cache can fill.—*Analysis written by Russell O. Iwanchuk*

How We Tested

Our test network consisted of a mix of 28 Dell OptiPlex GXa (Pentium II/233 with 32MB of RAM), Dell Dimension XPS Pro200n (Pentium Pro/200 with 32MB of RAM), and Dell Dimension XPS P166s (Pentium/166 with 32MB of RAM) PCs connected via SynOptics 28115 Fast Ethernet switch to the proxy server. We installed the proxy server software on a dedicated server: a Dell PowerEdge 2200 (a Pentium Pro/233 with 128MB of RAM) running Windows NT Server 4.0 and Service Pack 3. We connected the proxy server to a simulated Internet connection: two NetGear RH348 ISDN routers that communicated over a 128-Kbps ISDN line. To simulate an ISP, we connected a second router to a Web server hosting the HTML files. For automating client requests and collecting data, we used our ZD WebBench 2.0 test, which has a workload of 60MB in HTML files of various sizes.

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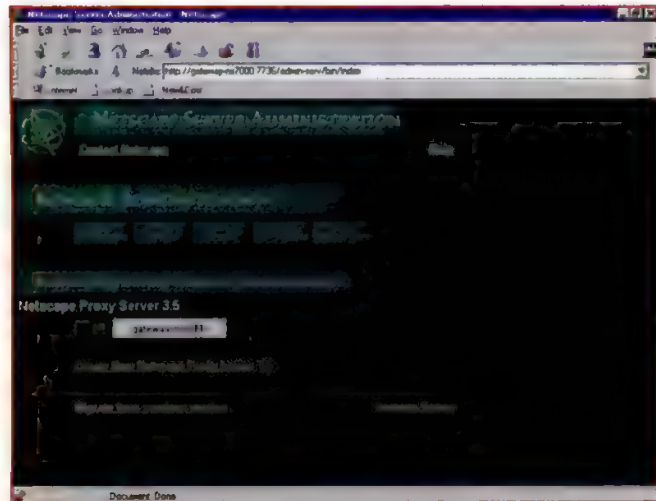
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has a low price tag, and has features well suited to larger, mixed environments. Netscape Proxy Server 3.5 provides the most control over page caching we've seen, flexible content filtering, support for LDAP as well as for the CARP and ICP protocols, and improved security. But configuration was the most dif-

information required was the directory path and the administrator's user name and password. If you rely on an LDAP directory to manage lots of users, Netscape Proxy Server will use it to manage users and control access—a strong plus.



NETSCAPE PROXY Server 3.5's Administrator page lets you define user settings, security, and other global settings.

ficult we experienced. Still, if you're familiar with SuiteSpot servers and appreciate the granular control their painstaking configuration sessions yield, this server's for you.

Installation was extremely easy; the only

information required was the directory path and the administrator's user name and password. If you rely on an LDAP directory to manage lots of users, Netscape Proxy Server will use it to manage users and control access—a strong plus. The unit doesn't require a client component and automatically configures client machines that have Netscape Navigator installed. Configuring systems using alternative browsers requires a client install program, though.

Like other SuiteSpot servers, Netscape Proxy Server uses a browser and Java applets for configuration. This method required us to use two separate HTML pages: an admin page to set up and configure user and group access, as well as a proxy page for controlling content filtering, protocols, and page caching. This was counterintuitive and time-consuming; the documentation helped, but we would have pre-

ferred more detail. Opting for the default settings for users, routing, and so on can speed up the whole process.

Though tough to configure, this server provides robust control over page caching. You can set up a default expiration time frame for all HTML documents in the cache or use a last-modified multiplier to specify how long objects should remain in the cache. The proxy server determines the last time a page was updated at the Web site; then the page's age is compared with the multiplier. For example, a page that was updated last week would be updated in the cache weekly, and a page that hasn't been updated for several months would be kept in the cache for coming months as well.

Like Microsoft Proxy, MidPoint Gateway and WinProxy, Netscape Proxy Server supports Socks 5, so it can pass applications such as streaming audio and video. Moreover, the server can block MIME types, such as ActiveX and Java. Like Microsoft Proxy, the Netscape product provides rudimentary URL filtering to let you block specific pages by users or groups. CARP and ICP support lets you connect multiple proxy servers to form a hierarchy; when a user requests a page or file to download, the proxy server will poll other servers in the hierarchy before sending the request out to the actual Web server. Netscape Proxy Server also provides detailed log files,

WEB CACHING DEVICES

Quick and Easy Cache

Proxy-server software packages are complex products that demand considerable time and effort to set up and configure. A compelling alternative is the **Cobalt CacheQube** (\$1,899 list). This turnkey caching proxy server is easy to install and doesn't require a dedicated PC or an intricate knowledge of IP services. The CacheQube can cache HTTP, FTP, and Gopher traffic, including EXE files, Java, and Java applets. It packs in everything you need to increase performance for your Internet access but doesn't provide user-level security or content or protocol filtering.

Looking more like a blue toaster than an Internet caching appliance, the CacheQube uses a 150-MHz, 64-bit MIPS processor with 64MB of RAM and a 4.3GB hard disk. The box includes a 10-Mbps and a 10/100-Mbps Ethernet connector; the internal CPU runs

a customized version of the Linux OS.

There are two options for connecting to the network. To configure the CacheQube as a traditional proxy server, we simply connected one of the Ethernet ports to our existing network. Though the easiest setup, it required us to configure each client PC's browser to point to the IP address of the CacheQube. A more powerful method is to connect one port to the LAN and the second to a router for enabling transparent caching. This forces Internet requests to travel through the CacheQube and doesn't require browser reconfiguration. Once you've connected the device, you use the front-panel LCD to configure the IP address and subnet mask for each network connection.

When the unit has an IP address, you can use a browser to complete the configura-

tion. The settings let you select how long a page stays in the cache before the server checks the site for an updated version, the amount of cache a single document can use, and how much disk space to devote to logging information. The CacheQube provides detailed log files on cache, CPU utilization, network traffic, and bandwidth savings, as well as a list of sites you can view by number of hits, by site, or by user. And the log files are compatible with the CERN, Harvest, and Squid proxy standards.

Although the CacheQube seems geared only to small businesses, it provides powerful features that make it a good choice for larger organizations with hundreds of users as well. It works with the ICP protocol—which lets you set up a hierarchy of proxy servers, stretching across a WAN—and Cobalt's proprietary InstaCache Cluster technology lets you connect up to six devices to balance Internet traffic. (Cobalt Networks Inc., Mountain View, CA; 888-702-6225, 650-930-2500; www.cobaltmet.com, 624 at www.pcmag.com/infolink.)—SR

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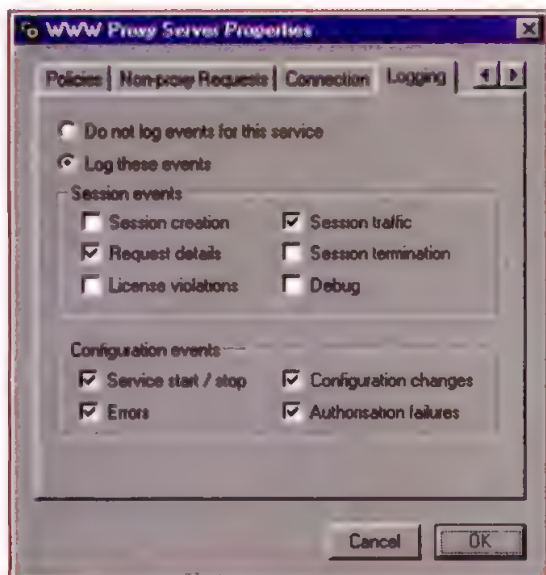
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Net Tools

PROXY SERVERS



WINGATE PRO 2.1 lets you keep an audit log of traffic for specific users, groups, or protocols.

viewable via a browser. You can save these as text files for use with other applications and search them using keywords.

Administrators who like SuiteSpot's wealth of configuration options won't be disappointed with this Netscape server.—SR

WinGate Pro

Unlimited users, \$700 list per server. Deerfield.com, Gaylord, MI; 800-599-8856, 517-732-8856; www.deerfield.com. 620 at www.pcmag.com/infolink.

● WinGate Pro 2.1 offers impressive and unique features that rival those of MidPoint Gateway (our Editors' Choice), with a lower price. Like MidPoint Gateway, WinGate lets you aggregate multiple connections, but it also lets you combine T1 and cable modem connections as well as analog modems and ISDN adapters. Moreover, WinGate Pro is the only server here that lets you dedicate a link to a specific protocol or set of protocols, ensuring that mission-critical protocols such as SNMP and POP3 will always receive enough bandwidth.

Installation was quick; the server component, WinGate Engine, runs transparently on Windows 95, 98, and NT servers. The client PCs must be configured manually, as with WinProxy. This requirement mandates the companion program GateKeeper, which can run on any PC—or remotely.

GateKeeper gives you fine control over protocols and provides easy-to-use tools for managing user and group lists. You can restrict access by time of day, protocol type, or IP address. GateKeeper's audit-log feature is unique, letting you log traffic for specific users, groups, or protocols. When you're not per-

forming management functions, the program displays an informative real-time activity monitor, similar to those of MidPoint Gateway and WinProxy.

WinGate Pro lets you configure the server to use a specific interface (or combination of interfaces) for each protocol. This lets you reserve one link exclusively for POP3, for example, to ensure there's plenty of bandwidth for your e-mail, even if the other links are loaded down with Web traffic. There's also a flexible scheduler (similar to WinProxy's) that lets you start and stop specific services, dial or disconnect modem links, and perform cache and user database-maintenance functions. You can set the scheduler to dial (and

stay connected to) your ISP, providing a full-time link during specified times and speeding users' Internet access.

Deerfield.com's Lite version of WinGate provides the same functionality as WinGate Pro minus remote management and user au-

thentication. The single-user version is free and ideal for sharing a cable modem or ISDN connection in a two-

PC home or on a SOHO LAN. All versions are available for a free, 30-day trial.

WinGate Pro provides some excellent features that will appeal to midsize businesses and the SOHO set alike.—LF

WinProxy

Unlimited users, \$299 list. Osis Software, Pleasanton, CA; 888-946-7769, 510-734-1900; www.winproxy.com. 621 at www.pcmag.com/infolink.

● WinProxy 2.1f (\$299 list) is the lowest-priced entry here. Though similar to WinGate Pro, it lacks that product's ability to aggregate multiple connections. Still, WinProxy offers good capabilities, a simple-to-use interface, excellent user-access control, and real-time monitoring—adding up to an excellent value.

WinProxy installs quickly and easily under Windows 95, 98, or NT. Like MidPoint Gateway, WinProxy provides a configuration wizard that walked us through the process. If you need to, you can go back and rerun the

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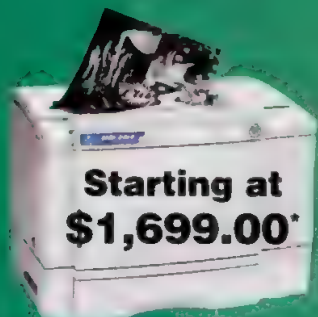


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— PC Magazine, May 1998

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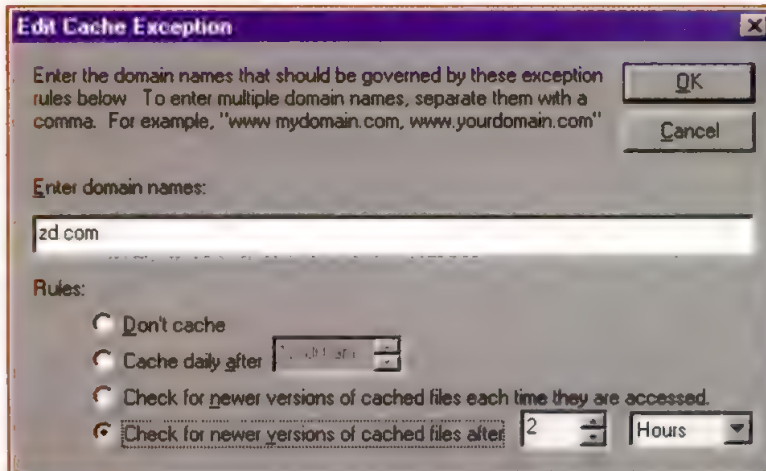
wizard at any time without losing the existing setup information. WinProxy provides a useful customized client-setup screen that displays the information you'll need to configure applications. But you'll need to configure each PC manually.

The WinProxy user interface—like the ones in MidPoint Gateway and WinGate Pro—displays real-time proxy activity. WinProxy can log all proxy-server activity to a text file on the server machine, or it can send log details to a separate logging application that runs on a different PC. Since the product lacks remote management capabilities, the feature enables the administrator to perform this function at a different location. The log files provide detailed information yet can grow quite large over time.

WinProxy offers tight control over user access. You can restrict access by user name or IP address, and you can specify the protocols all user or PC can ac-

cess. This feature lets you grant Web-only access to some users while providing a more comprehensive suite of protocols (news and mail, for example) to others. You can tailor each user's Internet access to individual needs while restricting access to protocols unrelated to business.

The product's cache-management fea-



WINPROXY 2.1f's cache management lets you download specific Web pages at specific times of day.

Net Tools

PROXY SERVERS

tures let you specify the domains from which pages should or shouldn't be cached. Also, you can easily configure WinProxy to download certain Web pages at specified times of day, as does MidPoint Gateway. WinProxy includes rudimentary content filtering by letting you restrict access to specific sites by name or IP address.

This product can automatically dial into your ISP and keep the connection for a specific time period, speeding up access to the Internet. WinGate Pro also has this feature, but additionally, WinProxy lets you restrict Internet access to certain times of the day as a security or cost-saving measure.

For LANs with three or fewer users, Osiris offers the full-featured WinProxy Lite (\$59 list). Both are available for trial use on the Web. In summary, WinProxy provides a strong set of features at a bargain price.—**LF** 

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Net Tools

FROM THE BENCH

WIRELESS NETWORKING

Standard Wireless

By Bruce Brown

The world of wireless networking has been dominated by proprietary niche products that target vertical markets. But with most vendors adopting the IEEE 802.11 standard, manufac-

We tested the BayStack 660.

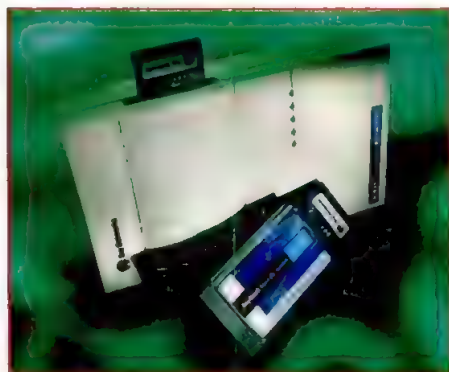
The Bay systems use wireless hubs called Access Points, which connect to Ethernet LANs via cable. These provide network connectivity for up to 50 users with PC Card wireless NICs. The BayStack 660 is backward-compatible with older Bay wireless products, and it can allow up to 15 overlapped Access Points in an area, supporting many concurrent wireless users. The BayStack 660 isn't backward-compatible and can support only 5 overlapping Access Points but is faster with a larger range.

Setup was simple.

To activate an Access Point, we plugged in the AC adapter and attached it to the existing Ethernet network. The PC Card NIC includes drivers for Microsoft Windows 95, 98, and NT, and installed without incident. The helpful management utilities show signal strength and bandwidth utilization in colored bars.

In testing, the BayStack cards quickly acquired the signal from an Access Point located on the first floor of a three-story building. We moved freely throughout the building and maintained good signal strength without interruption, even on the top floor.

BayStack 660 Wireless LAN. List price: \$1,799 per Access Point, \$569 per PC Card. Bay Networks Inc., Santa Clara, CA; 800-822-9633; www.baynetworks.com. 627 at www.pcmag.com/infolink.



STANDARDS-BASED: The BayStack 660 is one of the first 802.11-compliant products.

turers are striving to build products that interoperate, hoping to attract mainstream corporate users. Bay Networks' 802.11-compliant BayStack 660 series includes versions that implement both *frequency-hopping* and *direct sequence* technologies.

The BayStack 660 Wireless LAN (Per Access Point, \$1,499 list; \$499 per PC Card) uses frequency-hopping technology, which has a rated maximum bandwidth of 1 Mbps per network segment, and a coverage radius of up to 250 feet indoors and 1,000 feet in the open. The BayStack 660 Wireless LAN (per Access Point, \$1,799; per PC Card, \$569) uses direct sequence technology, which has a claimed maximum bandwidth of 2 Mbps, and a coverage radius of up to 300 feet inside and 2,000 feet in open space.

10/100 HUBS

Fast, Flexible, and Cheap

By Martin Wong

Until recently, the only way you could share resources between Ethernet and Fast Ethernet devices was by adding a switch. But their high cost has kept switches out of the reach of many smaller companies and made them an impractical solution for those looking for a simple migration path to Fast Ethernet.

But the recent debut of auto-sensing 10/100 hubs introduced a compelling alternative to switches. These hubs can connect Ethernet and Fast Ethernet devices, as well as transfer data between different-speed ports, obviating switches. The hubs negotiate network speeds by way of a built-in switching chip. The average price per port—around \$35—is much less than even the cheapest switches. Though these hubs lack the manageability features of switches, you can use packet sniffers for monitoring and managing a shared-hub network. Companies looking to connect legacy equipment or up-

and technical support. Also, if you've already purchased other infrastructure products from one of these companies, you may want to stick with the company you've invested in. One-stop technical support is handy, and the uniform appearance is more aesthetic.

Though switches are still faster and their prices have come down to affordable levels, these hubs provide excellent expandability for about half the price.

D-Link DSH-8

The largest supplier of unmanaged Ethernet hubs last year, D-Link recently started shipping its 10/100 SOHO hub line. At only \$27 per port, the D-Link DSH-8 (\$249 list) is one of the cheapest hubs in this roundup. But this is offset by a one-year warranty—the shortest we saw—though D-Link does provide free lifetime technical support.

The hub's gray metal case is compact, and the included kit makes mounting it on the wall easy. The integrated power supply



NEW HUB TRICKS: D-Link, Intel, Linksys, and NetGear all offer auto-sensing 10/100-Mbps hubs.

grade to Fast Ethernet incrementally will find these products a convenient and economical solution.

Our testing showed that the hubs performed almost identically. Price should be a major factor in your buying decision; also keep in mind the length of the warranty

enabled us to use a standard PC power cable; the others require an external power unit. Front-panel LEDs display speed and connectivity per port, 10- and 100-Mbps collisions, and power. The hub lacks utilization lights for traffic, however, as seen on the NetGear

CROSS TALK



Frank, there's finally an easy method of integrating 10- and 100-Mbps devices without turmoil, segmentation, or unequal traffic. Administrators used to need the right number of the right kinds of ports. These hubs make it easy to mix and match on the desktop without worrying about the wiring closet.

unit. You can connect the DSH-8 to a second hub or a switch via the uplink port.

The documentation was adequate, consisting of a small pamphlet with information on installing and connecting the hub, and some networking basics. But we would have preferred something more detailed, as was provided by Intel and NetGear.—*Ryan Snedegar*
D-Link DSH-8. List price: \$249. D-Link, Irvine, CA; 714-788-0805; www.dlink.com. 628 at www.pcmag.com/infolink.

Intel 8-Port 10/100 Fast Hub

The newest entry to the InBusiness family of networking products is the Intel 8-Port 10/100 Fast Hub (\$499 list). It features the same design and appearance as its siblings, and physically stacks with them. At a costly \$50 per port, however, the Fast Hub is hard to recommend, unless you've already invested heavily in the Intel brand.

Though we liked the fact that each port on the hub features separate colored LEDs for Ethernet and Fast Ethernet operation, the Fast Hub is the only unit we tested that places the LEDs on the opposite side from the ports, making it difficult to get an at-a-glance status. The unit runs quietly, however, and is the second-smallest hub in the roundup.

The hub justifies some of its price with thorough documentation and a lifetime warranty. In

These are the best problem-solving devices I've seen in a while, Toni. Some of the best technology goes into simple-looking products. Providing auto-sensing capabilities at under \$50 per port is a technological tour de force. They will be on every network manager's shopping list.



addition to the basic installation instructions, it provides a friendly, full-color foldout and a helpful pamphlet that answers a beginner's typical questions. Intel is the only company to offer a lifetime warranty, but the company includes only 90 days of free technical support.—*Brad Walden*
Intel 8-Port 10/100 Fast Hub. List price: \$499. Intel Corp., Hillsboro, OR; 800-538-3373, 503-264-7354; www.intel.com. 629 at www.pcmag.com/infolink.

Linksys EFAH08W

At \$25 per port, the Linksys EFAH08W (\$200 street) was the cheapest hub we tested. The latest addition to Linksys's EtherFast line of networking products, the EFAH08W appeals strongly to the bottom line in a category with few differentiators.

Though it is the largest hub we tested, the EFAH08W was still very compact and fit easily on a desktop. Like the other units, it has eight autosensing ports as well as an uplink port for connecting to another hub or switch; however, it is the only one that isn't wall-mountable. A row of 10- or 100-Mbps LED indicators sits next to the ports, clear and easy to read.

Although not as detailed as the NetGear or Intel documentation, the unit's small included manual has basic information about installing the hub on a network, and contains all the information you'll need. The EFAH08W comes with

Net Tools FROM THE BENCH

toll-free lifetime technical support as well as a five-year warranty.—*Martin Wong*
Linksys EFAH08W. Street price: \$200. Linksys, Irvine, CA; 800-546-5797, 949-261-1288; www.linksys.com. 630 at www.pcmag.com/infolink.

NetGear DS108

With little variation among their products, hub vendors need to present their core feature sets as cleanly as possible. With the NetGear DS108 (\$280 street), NetGear does just that, at a reasonable \$36 per port. In addition to offering the best design in this roundup, unique utilization LEDs, and an ultrasmall footprint, the company includes 24-

hour, toll-free technical support under a five-year warranty.

The DS108 hub features two unique utilization bars for the Ethernet and Fast Ethernet segments, and each port has two status LEDs. We favor this design, which let us determine link state, speed, and activity with a glance. The DS108 was also the only hub without a fan. No moving parts means there's less to go wrong, and the unit was the quietest here. The hub trades the traditional uplink port for a push-button dual-function port.

The documentation was excellent. We found the foldout guide useful for first-time installers, though it wasn't as slick as Intel's full-color poster.—*Kevin Young*
NetGear DS108. Street price: \$280. NetGear Inc., San Jose, CA; 888-638-4327, 408-988-2400; netgear.baynetworks.com. 631 at www.pcmag.com/infolink.

SERVER MANAGEMENT

Servicing Servers

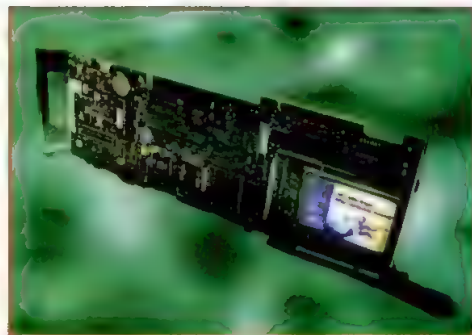
By Jeffrey Witt

Network managers looking to minimize server downtime should consider the Intel LANDesk Server Manager Pro (\$995 list). This hardware and software combination provides round-the-clock server monitoring, and it alerts you when problems occur. Though similar products exist, the LANDesk is the only one that works on any vendor's server on a NetWare or Microsoft Windows NT network.

We had no difficulty installing the LANDesk hardware in our Dell 2200 server running Windows NT 4.0. The PCI adapter—referred to as the Emergency Management Card 2 (EMC)—is actually a computer in itself, complete with CPU, RAM, and OS. For network and remote capabilities, the EMC includes an on-board Intel Global

Combo PC card with modem and 10/100 Ethernet interface.

Because it operates independently from the host server, the EMC draws power from a separate Intelligent Power Module (IPM). In addition to powering the card, the IPM acts as a power switch that lets the EMC shut



MINICOMPUTER: The Intel LANDesk Server Manager Pro card packs its own CPU and modem.

down your Windows NT and NetWare servers in case of adverse conditions, or reboot them if they've hung or lost power.

We installed the Server Manager console on a Windows 95 client easily. You can let DHCP assign

an IP address to the EMC or manually configure the IP or IPX address. The Windows-based client has a clearly laid-out GUI interface that we like. As part of the software install, we loaded the Server Manager agent on the same server. This provides data to the console based on responses from the OS and the EMC.

The agent let us monitor and manage nearly 200 server conditions such as disk usage, memory conditions, and CPU utilization; it also let us view historical data. It provided real-time DMI 2.0 statis-

tics on system voltage and temperature levels. In configuring alert notifications, we were able to set thresholds at three levels and to select notification methods such as pager or e-mail. The agent let us remotely control the host Windows NT server with both network and modem connections, perform warm reboots, and power the server up or down.

Intel LANDesk Server Manager Pro. List price: \$995. Intel Corp., Hillsboro, OR; 800-538-3373, 503-264-7354; www.intel.com, 629 at www.pcmag.com/infolink.

REMOTE MANAGEMENT

Mobile Manager

By Steve Rigney

Supporting a large, mobile workforce is a tough job. You're forced to troubleshoot problems remotely and can't distribute new software until users come back to the office. Fortunately, Callisto Software's Orbiter 2.0 (\$5,000 list, plus \$150 per client) makes maintaining your staff easier by letting you diagnose problems remotely, update software, and schedule preventative scans—all using an e-mail connection. Though its initial cost is higher than competing RightState Mobile Automation's, Orbiter's lower per-client cost

utility that lets you create jobs for your remote PCs; you can put it on the server or on any managed Windows 95, 98, or NT laptop. The small client agent runs in the background on managed PCs.

Though we had to create a Windows NT and an e-mail user name for the server manually, installation was a snap. Note, though, that Orbiter works only with proprietary mail types from such programs as Lotus Notes, cc:Mail, and Microsoft Exchange, not with standards-based POP3/IMAP4 servers. Users in the office will appreciate Orbiter's ability to communicate faster

over TCP/IP.

Orbiter makes easy work of distributing software and files to remote PCs. We simply selected the network files and the names of the target PCs. Orbiter breaks the package into small sections and sends them via e-mail. Once you order a job, the server

sends the package along with regular e-mail. The client auto-detects incoming packages, installs the new files, and sends a report to the server the next time the mobile user checks e-mail.

To track whether users are

futz around with the settings, Orbiter's Change Analysis feature lets you compare the registry, file structure, and other configuration settings between two PCs, or between a single PC's settings at two different points in time. This lets you pinpoint

changes when you're troubleshooting a problem remotely.

Orbiter 2.0. List price: Server, \$5,000; \$150 per client. Callisto Software Inc., Wheaton, IL; 630-682-8200; www.callisto.com, 633 at www.pcmag.com/infolink.

By Steve Rigney

PRINT SERVERS

The Printer Hub

Finally a company has put the print server where it belongs: in the wiring closet with the other servers. Though the ExtendNet 100zx (\$840 street) looks like a hub, the unit shares printers, not PCs. This is the first print server that can host six printers simultaneously, at distances greater than serial- or parallel-port limits. In addition, the 100zx features excellent administration through a simple, browser-based interface.

The size of an Ethernet hub, the 100zx includes everything you need to mount it on a standard 19-inch rack. At \$140 per port, it's slightly cheaper than competitors such as the three-port HP JetDirect EX Plus3, which

figured the device for our network. A nifty test button on the front let us print out the current configuration settings. Though the device includes a well-done DOS configuration utility, we preferred the intuitive browser-based management tool. The 100zx can automatically lease an IP address from existing BootP or DHCP servers, or you can assign one via an ARP



HUB OR PRINT SERVER? Though it looks like a hub, the ExtendNet is really a print server.

costs \$160 per port. The device works with Microsoft Windows NT, Windows 95 and 98 clients on networks using TCP/IP, IPX, or DLC protocols, and also with NetWare.

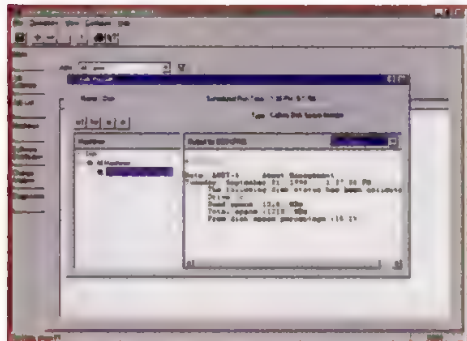
Installation was a breeze. We simply connected to the LAN via a back-panel, auto-sensing 10/100 port, and attached the printers using the six included Z-Link connectors. The size of a pack of playing cards, one of these devices plugs into each printer's parallel port. The Z-Link connects to the 100zx with ordinary Category 5 UTP cable, which lets you situate your printers as far as 100 feet from the server—farther than any other print server available.

After installing the server and connecting our printers, we con-

command. Once assigned, we simply typed the address into our browser and provided the default password.

From the browser, we quickly set up our unit as a NetWare printer server (Pserver) and provided the proper IP information for our Windows NT network. Upon saving the configuration, we were able to print from both NetWare and Windows NT clients. But because Windows 95 doesn't include built-in IP printer support, printing from Windows 95 clients required us to install the bundled TCP/IP printer drivers first.

ExtendNet 100zx. Street price: \$840. Extended Systems Inc., Boise, ID; 800-545-9934, 208-322-7800; www.extendedsystems.com, 634 at www.pcmag.com/infolink.



ALL DONE: Orbiter provides log file information on remote PC's settings and the status of jobs.

makes it the cheaper solution for large organizations.

Orbiter has three components. The server works as a service on Microsoft Windows NT and handles job tasks and logging. The administrator is a Windows-based



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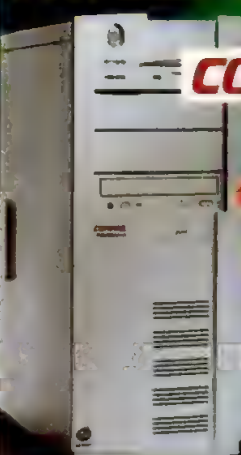
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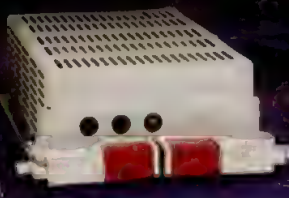


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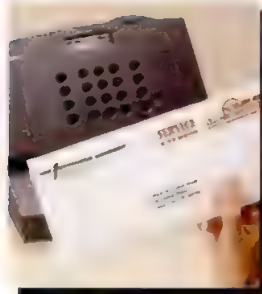
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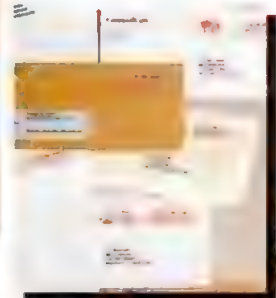
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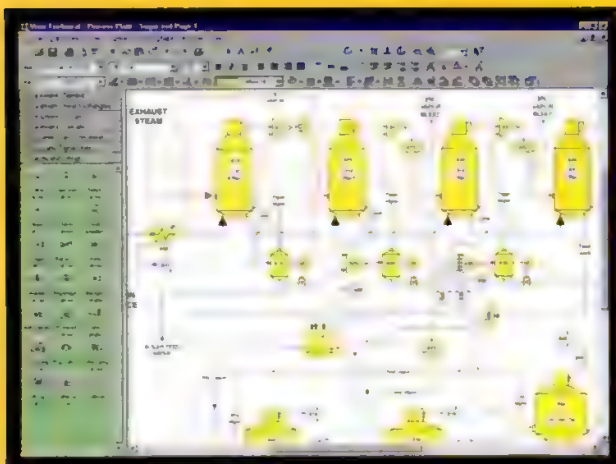
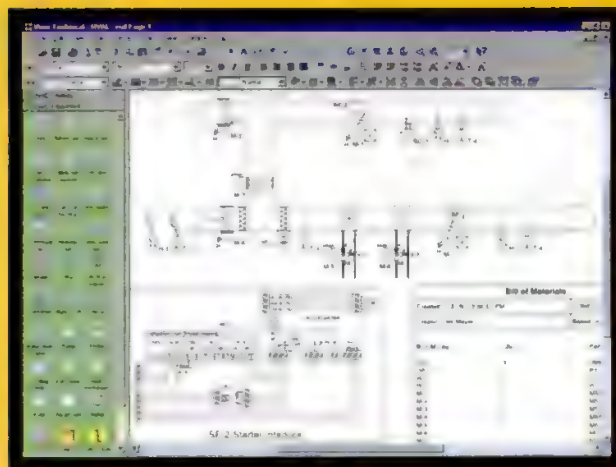
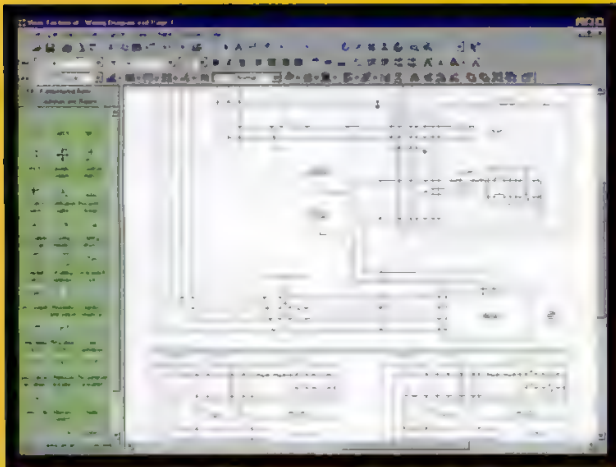
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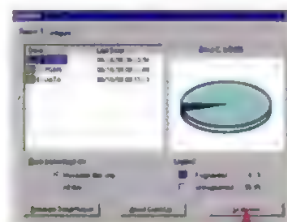
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INSIDE

TUTOR: Few of us pay any attention to headers, the cryptic information that accompanies e-mail messages. Taking a close look at headers can tell you a lot, such as the route a given note took to get from the sender's keyboard to your mailbox. *Page 299.*



UTILITIES: The disk defragmentation utilities that Microsoft includes with Windows 95 and 98 are limited and—dare we say—even flawed. CrackUp, this issue's free utility, monitors your hard disks' condition and alerts you when file fragmentation reaches a level you define. CrackUp also calculates fragmentation more accurately. *Page 305.*



PC SOLUTIONS:

Automating your deletions from the Windows 95 registry; editing link names in Microsoft Internet Explorer 4; recovering lost passwords—and how much they really safeguard your data; finding workarounds to count occurrences of entries in Excel ranges; turning off table borders in Word 97; preparing your Access applications for the year 2000; and more. *Page 313.*

SQL: The Universal Database Language

An introduction to creating and manipulating relational databases.

By Gabrielle Gagnon

SQL is often cited as being the lingua franca of relational database management systems. Certainly no other database language has found such wide acceptance among such a broad range of products. Since it was first standardized in 1986, SQL has become universally adopted. Even nonrelational database systems support a SQL interface. But unlike other computer languages such as C or COBOL, which are the exclusive domain of programmers, SQL is employed by a variety of professionals. Programmers, database administrators, and business analysts alike use SQL to access information. A working knowledge of the language is valuable to anyone who uses a database.

This two-part article will help you learn the SQL basics. We'll give you back-

ground on the language (dispelling some myths along the way), introduce you to relational theory, and teach you enough hands-on SQL to get you securely started.

How easy is it to learn SQL? That depends on how much you want to learn. There's a lot of material to master if you want to become an expert. SQL has come a long way from the original 23-page research paper that started it all back in 1974. The International Standard Database Language SQL (informally called *SQL-92*) document is over 600 pages long, and that doesn't cover the vendor-specific extensions from Microsoft, Oracle, Sybase, and other database vendors that have enhanced SQL for use with their products. A lan-

guage as rich and varied as SQL can't be taught completely in one or even a few articles. Volumes have been written on the subject.

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You'll find all of the articles, examples, and code files in this section at PC Tech Online.

But you don't have to be a SQL expert to be productive. Just as a tourist in a foreign country can get by with some basic vocabulary and a few rules of grammar, a SQL novice can accomplish a lot by knowing just a little. In this article, we'll cover fundamental SQL statements, talk about selection criteria, and introduce you to reporting functions. By the time you've finished, you should be able to create and populate tables, construct queries, and run reports, and you'll know enough to go out confidently and explore the rest of SQL on your own.

WHAT IS SQL?

SQL is a special-purpose, nonprocedural language that supports the definition, manipulation, and control of data in relational database management systems. It's a special-purpose language, because you can use it only for handling databases; you can't write general-purpose applications with it. (To write an application, you have to embed SQL in some other language, and it's frequently used that way.) That's why SQL is also known as a *data sublanguage*. A sublanguage can be used with application languages, but it is not a full-fledged application language. Also, a full-featured application language usually includes semantics for procedures, whereas SQL is nonprocedural. It doesn't specify *how* something should be done, it just specifies *what* should be done. In other words, SQL is concerned with results rather than procedures.

By far the most important feature of SQL is that it provides access to *relational* databases. That's so fundamental to SQL that many people think the terms *SQL database* and *relational database* are synonymous. But as you'll soon see, they're not. In fact, the SQL-92 standard doesn't even mention the term *relation*.

WHAT IS A RELATIONAL DATABASE SYSTEM? Simply stated, a relational database system is based on the relational model for managing data.

The relational model was first introduced in a paper published in 1970 by Dr. E. F. Codd. It provided a mathematical basis for structuring, manipulating, and controlling data, and it abstracted data from any physical implementation. Prior to that time, database users had to know how records were physically linked in order to access them. When the physical structure of a database was changed (for performance reasons, for example), programmers had to rewrite their applications, even if the logical structure remained the same. In the relational model, data is separated from application programs. In fact, the model said nothing whatsoever about how data should be stored or accessed. It dealt exclusively with how data was seen from the user's point of view. The relational model significantly changed the way people thought about managing data. It transformed database technology from an art into a science and revolutionized the industry.

RELATIONAL MODEL BASICS

In the relational model, a *relation* is represented as a table of information. It has one or more *attributes*, which correspond to the

columns of the table, and zero or more instances of data with those attributes (called *n-tuples* or simply *tuples*), which correspond to the rows (see the table "The Relational Model," below).

For any given tuple, the actual values of its attributes must be taken from the attributes' *domains*. A domain is essentially a data type that defines the set of all permissible values.

For example, assume there's a domain called "Days-of-the-week" that consists of "Monday" through "Sunday." If a relation had

THE RELATIONAL MODEL

		Attributes (columns)			
		FirstName	LastName	PhoneNumber	Address
Tuples (rows)	1	Tom	Stevens	123-4567	1313 Mockingbird Ln
	2	George	Antimony	890-1234	1 Exchange Place
	3	John	Contrary	567-8901	121 Melrose Place
	4	Jim	Tucker	234-5678	83 Knots Landing
	5	Earl	Huckstable	901-2345	15 Maple St
		Relation (table)			

a single attribute of that domain called WEEKDAY, every tuple in the relation would have to contain one of those values in its WEEKDAY column. A WEEKDAY value of "January" or "Cat" wouldn't be allowed.

Notice that we said an attribute had to contain one of those values. It couldn't contain more than one. In addition to being constrained to a domain, attribute values have to be *atomic*. That is, they have to be elementary; they can't be broken down into smaller parts without losing their meaning. An attribute's value containing both "Monday" and "Tuesday" can be broken down into two parts that still represent days of the week, so that value is not atomic. But if you broke "Monday" down into smaller parts—the letters M through y—they wouldn't mean anything by themselves, so "Monday" is an atomic value.

Relations have other properties as well. Most important, they have the mathematical property of *closure*. That is, any operation performed on a relation yields another relation. This lets you perform mathematical operations on relations with predictable results. It also allows operations to be abstracted into variable expressions and nested.

In his original paper, Dr. Codd defined a collection of eight operators called *relational algebra*. Four of those operators, *union*, *intersection*, *difference*, and *Cartesian product*, were based on traditional set theory, but the rest were developed specifically for rela-

What's in a Name?

When IBM began implementing Dr. E. F. Codd's relational database model in the early 1970's, Donald Chamberlin and others at IBM's research division developed a prototype language called *Structured English Query Language*, or SEQUEL for short. Later, IBM expanded and revised the language, dubbing it SEQUEL/2. SEQUEL/2 became the application programming interface (API) for IBM's first relational database system prototype, System/R. For legal reasons, IBM eventually changed the name SEQUEL/2 to SQL. That's why many people and reference books today, like this magazine, use the pronunciation "sequel" and spell it out as Structured Query Language.

But as the standards people like to emphasize, the early SEQUEL prototypes were not the same as the SQL language that was adopted by various standards organizations. Jim Melton, an editor of the SQL-92 standard, even went so far as to say that the public was "ill-served by persuasions that the word 'structured' accurately describes the language" (*Understanding the New SQL: A Complete Guide*, by Melton and Alan R. Simon. San Francisco: Morgan Kaufmann, 1993. ISBN: 1-55860-245-3). So officially at least, SQL stands for S-Q-L and nothing else.

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tions. Since then, Dr. Codd, Chris Date, and others have developed more operators. We'll discuss three of these relational operators—*project*, *select (or restrict)*, and *join*—later in this article.

SQL AND THE RELATIONAL MODEL

Now that you know a little about the relational model, we're going to ask you to forget about it. Well, not really, but at this point we should explain that even though SQL is based on Codd's relational model, it is not a full or faithful implementation of it. (That's one reason the SQL-92 standard doesn't mention relations.) For example, a SQL table is not exactly the same as a relation, because among other things, a SQL table allows duplicate rows and relations don't have duplicate tuples. Also, SQL doesn't support relational domains, although it does support data types to some extent. (Several prominent relational advocates are lobbying to include relational domains in a future SQL standard, however.)

Unfortunately, the disparity between SQL and the relational model has caused a lot of confusion and debate over the years. Since the focus of this article is to teach you about SQL, not relational theory, we won't discuss all of the discrepancies here. For now, you just need to know that because there are differences, relational terms and SQL terms are not always interchangeable. From now on, we'll only use SQL terminology. Instead of *relations*, *attributes*, and *tuples*, we'll refer to their SQL counterparts: *tables*, *columns*, and *rows*.

STATIC AND DYNAMIC SQL

You may have heard the terms *static SQL* and *dynamic SQL*. SQL is static when it is compiled and optimized prior to execution. We've already mentioned one form of static SQL when we talked about "embedding" it in C or COBOL applications. (This is also known as *embedded SQL*.) As you may have guessed, dynamic SQL is compiled and optimized during execution. Most end-user tools use dynamic SQL, because it enables you to write ad hoc queries. One way of executing dynamic SQL is through *interactive* or *direct invocation* (also known as *direct SQL*), where the SQL statements are executed interactively from a terminal. There are some differences in syntax and behavior between static and dynamic SQL, but we don't need to go into them here. The main point is that for the sake of simplicity, we will give our examples in direct SQL, since more people—nonprogrammers as well as programmers—can learn SQL that way.

SQL TUTORIAL

Now we're ready to begin writing some SQL code. If you have access to a SQL database and would like to try the examples as we go along, make sure to log on as a user with full privileges and to use an interactive SQL facility. (If your SQL database is on a network, you'll have to talk to your database administrator about getting privileges.) If you don't have access to a SQL database, don't worry: the examples are easy to follow. You don't need to try them out to understand what's going on.

The only way to make anything happen in SQL is to execute a SQL statement. There are several types of SQL statements, but they generally fall into three categories: data definition language (DDL) statements, data manipulation language (DML) statements, and data control statements. In a way, SQL is like three languages rolled into one.

DATA DEFINITION LANGUAGE STATEMENTS

Let's start with one of the fundamental DDL statements in SQL: the *CREATE TABLE* statement. There are several types of tables in SQL, but the two basic types are *base tables* and *viewed tables* (or *views*). Base tables are actual tables, and views are "virtual" tables; they're derived from base tables

values that you supply. Notice that column and data type are enclosed in parentheses. Generally in SQL, parentheses are used to group items together. Here, they are required to enclose the list of column definitions. The semicolon at the end is a statement separator. Use it at the end of each SQL statement.

Let's try an example. Suppose you want to keep track of all of your appointments in an appointment table. You could create such a table in SQL by entering the following statement:

```
CREATE TABLE APPOINTMENTS ( APPOINTMENT_DATE DATE );
```

Executing this statement creates a table named *APPOINTMENTS* consisting of a single column named *APPOINTMENT_DATE* with a data type of *DATE*. At this point, there are no rows, since the table is empty. (The *CREATE TABLE* statement only defines tables; the *INSERT* statement, discussed later, populates them.)

APPOINTMENTS and *APPOINTMENT_DATE* are called *identifiers* in SQL, because they identify specific database objects, in this case a particular table and column, respectively. There are

two types of identifiers in SQL: *regular* and *delimited*. Delimited identifiers are enclosed in double quotation marks and are case sensitive; regular identifiers are neither delimited nor case sensitive. In this article, we'll use only regular identifiers.

Identifiers must conform to certain rules. Regular identifiers can contain letters of the alphabet (any alphabet, not just Latin), numeric digits, and

underscores. (If you're familiar with Japanese Hiragana syllabary or Chinese, you can also include syllables and ideographs.) Identifiers can't contain any punctuation, spaces, or special characters (such as #, @, %, or !), nor can they begin with a digit or an underscore. Although it's possible to use some SQL keywords as identifiers, common sense should tell you not to try this. Also, because an identifier identifies something, it has to be unique within its namespace: You can't create a table in a database if a table of that name already exists, and you can't have two columns of the same name within a table. Remember that to SQL, *APPOINTMENTS* and *Appointments* are the same. Varying the case

A SAMPLE MULTICOLUMN TABLE

EMPLOYEES					
LAST_NAME	FIRST_NAME	HIRE_DATE	BRANCH_OFFICE	GRADE	SALARY
Smith	John	06/10/1980	Los Angeles	10	45000.00
Bunyan	Paul	07/04/1970	Boston	12	70000.00
Adams	John	01/21/1992	Boston	3	2350.00
Smith	Pocahontas	04/06/1976	Los Angeles	12	100000.00
Smith	Bessie	05/02/1940	Chicago	1	1500.00
Jones	Davy	10/10/1970	Boston	4	45000.00
Jones	Indiana	02/01/1992	Chicago	1	1500.00

but appear as actual tables to the user. The *CREATE TABLE* statement is used to create base tables.

The *CREATE TABLE* statement requires a table name and a list of columns along with their corresponding data types. There are several optional elements that you can also include in the *CREATE* statement, but for the moment, let's just deal with the required ones. The basic syntax is as follows:

```
CREATE TABLE table ( column datatype );
```

CREATE and *TABLE* are SQL keywords; *table*, *column*, and *datatype* are placeholders for

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won't make a regular identifier unique.

Technically, although you need only one column to create a table, to be at all useful most tables have more than one column. Let's change our syntax diagram slightly to reflect the optional columns:

```
CREATE TABLE table (
    column          datatype
    [ { . column    datatype } ] ) ;
```

We used square brackets to denote optional elements and curly braces to denote an element that can be repeated any number of times. (You wouldn't include these special characters in the actual SQL statement.) The syntax diagram now shows that we can include any number of columns. Notice the comma before the second column placeholder. Whenever you specify a list of items in SQL, you have to separate the items with commas.

Since our single-column APPOINTMENTS table isn't very realistic, let's create a more useful one. (We'll have to give it a different name, though, because we already have an APPOINTMENTS table in the database.)

```
CREATE TABLE APPOINTMENTS2 (
    APPOINTMENT_DATE DATE ,
    APPOINTMENT_TIME TIME ,
    DESCRIPTION VARCHAR ( 256 ) ) ;
```

Here we've defined a table called APPOINTMENTS2. As in our first example, it has a column called APPOINTMENT_DATE, to record the date of the appointment, and APPOINTMENT_TIME, to record the time. DESCRIPTION is a variable-length string of text of up to 256 characters. We used the VARCHAR (short for CHARACTER VARYING) data type, because we weren't sure how much space we'd need, but we knew we didn't want more than 256 characters. Character strings as well as some other data types take length assignments. These assignments have to be enclosed in parentheses to the right of the data type.

You may have noticed that we changed the spacing in our two examples. The first time, the entire statement was written in one continuous string, but the second time, we broke the line after the opening parenthesis and moved each column definition to a new

line. There's no rule in SQL that says we had to do that. Listing columns in a stack just improves readability. SQL is a free-form language to some extent. You can break up the lines or add indentation and spaces however you see fit. Use whatever spacing is easiest to read and understand.

Now that you have the basic form under your belt, let's create a more complex multi-column table. On the previous page there is a

```
CREATE TABLE table (
    column          CHARACTER (length)          [ constraint ] |
                   CHARACTER VARYING (length) [ constraint ] |
                   DATE                        [ constraint ] |
                   TIME                        [ constraint ] |
                   INTEGER                     [ constraint ] |
                   SMALLINT                    [ constraint ] |
                   DECIMAL (precision,         [ constraint ] |
                        decimal places)        [ constraint ] |
                   FLOAT (precision)           [ constraint ] |
    [ { . column    CHAR (length)              [ constraint ] |
                   VARCHAR (length)           [ constraint ] |
                   DATE                        [ constraint ] |
                   TIME                        [ constraint ] |
                   INT                         [ constraint ] |
                   SMALLINT                    [ constraint ] |
                   DEC (precision,             [ constraint ] |
                        decimal places)        [ constraint ] |
                   FLOAT (precision)           [ constraint ] ) ) ;
```

FIGURE 1: The syntax for the CREATE TABLE statement in SQL. Anything enclosed in square brackets ([]) is optional, and anything enclosed in curly braces ({}) can be repeated any number of times.

table called EMPLOYEES, which has columns for last name, first name, date-of-hire, branch office, salary grade level, and annual salary. To define this table, enter the following SQL statement:

```
CREATE TABLE EMPLOYEES (
    LAST_NAME CHARACTER ( 13 ) NOT NULL ,
    FIRST_NAME CHARACTER ( 10 ) NOT NULL ,
    HIRE_DATE DATE ,
    BRANCH_OFFICE CHARACTER ( 15 ) ,
    GRADE_LEVEL SMALLINT ,
    SALARY DECIMAL ( 9 , 2 ) ) ;
```

As you can see, we've introduced several new elements.

First off, the NOT NULL clauses at the end of the column definitions for LAST_NAME and FIRST_NAME are examples of a *constraint*. A constraint sets requirements that have to be met. In this case, we're telling the system that LAST_NAME and FIRST_NAME must have values when data is entered into the table; these columns can't be left blank. (Which makes sense, if you think about it. How could you

identify an employee without a name?)

Also, our example shows three new data types: CHARACTER, SMALLINT, and DECIMAL. We haven't said much about data types up until now. Although SQL unfortunately doesn't support relational domains, it does support a set of basic data types. It uses them to allocate storage, constrain comparisons, and restrict data entry to some extent, but it doesn't have true type-checking the way other languages do.

SQL data types fall into six categories: *character strings*, *exact numerics*, *approximate numerics*, *bit strings*, *date-times*, and *intervals*. We've listed all the categories here for completeness, even though we won't be discussing them all in this article. (Bit strings won't mean much to nonprogrammers.)

By the way, if you're wondering whether *date-time* is a typo, it isn't. It's the term the SQL standard uses to categorize most temporal data types. (Intervals are also temporal, but they've been given their own category.) You've already been introduced to two of the datetime data types, DATE and TIME, in our previous example.

Another data type you've already encountered, CHARACTER VARYING (or VARCHAR for short), is in the character string category. One of our new data types, CHARACTER or CHAR, is also a character string. But unlike VARCHAR, which is of varying length, CHAR is a fixed-length data type. LAST_NAME will always be 13 characters long, whether the employee's name is Poe or Penworth-Chickering. (In Poe's case, the remaining 10 characters would be padded by blanks.)

From the user's perspective, VARCHAR and CHAR look the same, so why have two types? The reasons mainly have to do with storage requirements and performance. Generally, fixed-length character strings provide slightly faster access time, but unusually long ones waste space. In our APPOINTMENT2 example, it wouldn't make much sense to set aside 256 characters for every appointment's description; most entries wouldn't require that much space. A name, on the other hand, also varies in length, but is usually 13 characters or fewer, so any lost space would be negligible. A good rule of thumb is, if you know that the length of

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The **DECIMAL** data type, usually used for monetary values, lets you specify amounts with a fixed number of decimal places. Because it is an exact numeric data type, you get back exact results when using it in mathematical operations involving decimals. (The approximate numeric data types such as **FLOAT** [floating point number] have rounding errors in their decimal values, so they're not appropriate for financial appli-

Although SQL unfortunately doesn't support relational domains, it does support a set of basic data types.

Now look at Figure 1 to see our updated CREATE TABLE syntax diagram, which reflects these new elements and shows the format for all the data types we've talked about so far. (There are other data types, but these are enough to get you going.)

That's all we have room for in this issue. In Part 2, we'll cover the Data Manipulation Language (DML) statements INSERT, SELECT, UPDATE, and DELETE. Along the way, we'll introduce you to selection predicates, comparison and logical operators, nulls, and three-valued logic. **PC**

Gabrielle Gagnon is a freelance programmer and technical writer.

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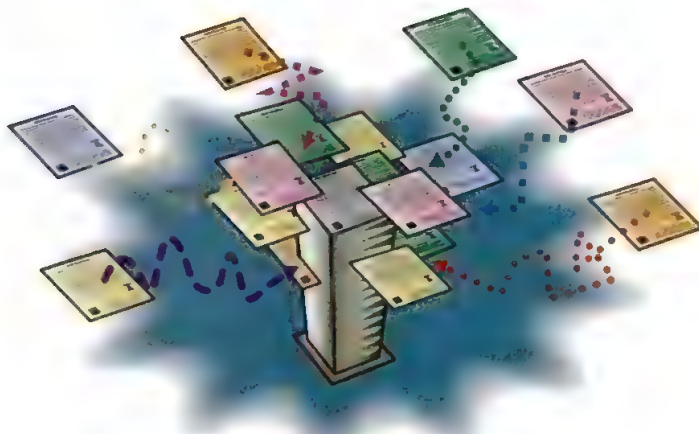


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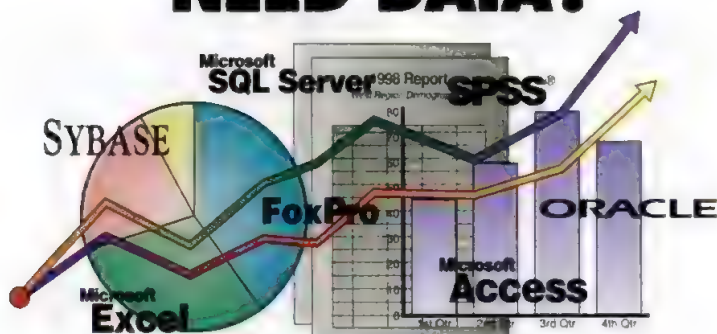


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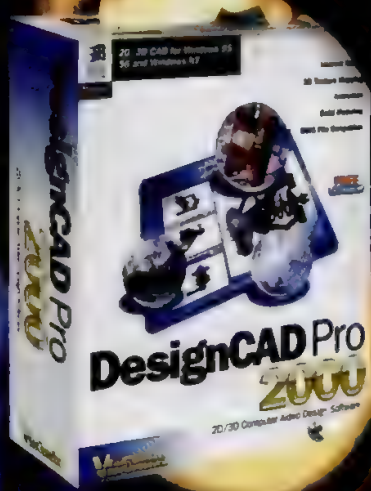


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3D SURFACE BENDING	YES!	NO	NO	NO	NO
HIDE SELECTED EDGES ON 3D SOLIDS	YES!	YES	NO	NO	YES
ANIMATION MODE	YES!	NO	NO	NO	NO
DRAW 3D SURFACE INTERSECTION	YES!	YES	NO	NO	NO
MOVE CURSOR IN 3D SPACE BY KEYBOARD	YES!	NO	NO	NO	NO
3D SYMBOLS INCLUDED	YES!	NO	NO	YES	NO
ANTI-ALIAS SHADING	YES!	YES	NO	NO	YES
AUTO-WELD MANY SHAPES TO ONE PERIMETER	YES!	NO	NO	NO	NO
CUT ONE PLANE FROM ANOTHER	YES!	YES	NO	NO	YES
MULTIPLE VERSIONS OF DXF & DWG EXPORT	YES!	YES	YES	NO	YES
AUTO-TRACE BMP TO DRAWINGS	YES!	NO	NO	YES	NO
VISIBLE NUMBERED SYMBOL HANDLES	YES!	NO	NO	NO	NO
DIGITIZER TRACING SUPPORT	YES!	YES	YES	NO	NO
DIRECT TWAIN SCANNER SUPPORT	YES!	NO	NO	YES	NO
ZOOM ALL VIEWS TO OBJECT SELECTION	YES!	NO	NO	NO	YES
PANELING: MULTI-PAGE PRINTOUTS TO SCALE	YES!	NO	NO	YES	NO
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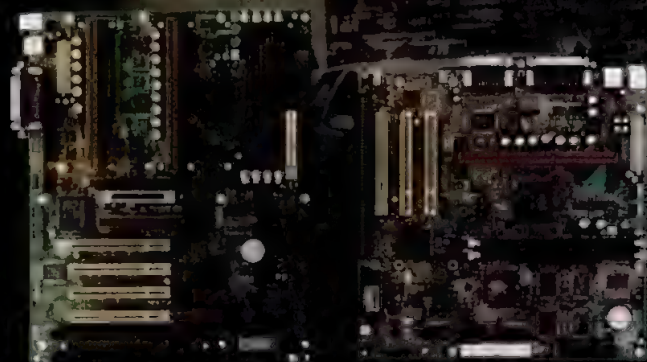
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E-Mail Headers, Even the Ugly Ones

All that cryptic information at the top of your e-mail messages can tell you a lot.

By Neil Randall

Before Qualcomm's Eudora e-mail package became a sophisticated corporate product, it offered one of the best options of all: The Fonts and Display section of the *Settings* dialog contained a radio button labeled "Show all headers (even the ugly ones)." Almost irresistible because of the wording, this option has since been changed to one called simply "Show all headers." It's accessible by an icon that says "Blah Blah Blah," though, so the humor hasn't entirely been lost. Whatever it's called, the option of displaying a long list of ugly-looking text at the beginning of each received e-mail message is offered by many e-mail clients. The text is called the message header or mail header.

Not all popular mail clients will display full header information. Double-clicking the top of the preview pane in Microsoft Outlook Express, for example, will reveal only partial headers. Most clients do support this feature, however. Microsoft Outlook 98 allows you to see full header information by double-clicking the top of the preview pane, and Netscape Messenger's *View* menu lets you choose among *All*, *Normal*, and *Brief* (see Figure 1).

The mail header contains a great deal of information, mostly about how an e-mail found its way to your mailbox. The problem is that this is not information you usually want. If you're like most people, you simply want to know that your postal mail actually got to you in one piece and more or less on time. In the same way, all you probably care about with your e-mail is that the messages addressed to you show up quickly in your incoming mail folder. The

route the messages took simply doesn't matter. As a result, today's e-mail packages, whether standalone or part of a browser suite, hide most header information by default. But in case you want to see every last ugly bit of header, most clients will allow you to do so by simply choosing that option in the program's preferences.

Why would you want to, though? First of all, headers are part of the technology you're using, and many users—including readers of technical sections of computer magazines—like to know how their technologies work. In addition, having this information can help you track problems with your account, your provider, or the electronic path along the Internet to your computer. Mail headers can

the Internet is designed so that a message traveling from Los Angeles to New York City can take a different route each time, depending on the routes available at the time of sending. In other words, though the stamped letter from Grandpa in L.A. would follow a fairly predictable route in the U.S. Postal Service's transportation scheme, messages from a much more wired Grandpa would take a different path each time.

READING A SIMPLE E-MAIL MESSAGE

Figure 2 shows the content of a simple mail header, simple because it was a message sent from one account to the same account. You can try this by sending a message to yourself. (Yes, the author's e-mail address is embedded here. Write him if you have a question about all this.)

The first header on an e-mail message is *Received:*, which shows the last mail host through which the message passed before being placed in the user's mailbox. In this case, the last leg of the message was from the machine named *vortex.uwaterloo.ca*, whose IP number is 129.97.42.40, to the machine named *watarts.uwaterloo.ca*, on Monday,

June 22, 1998, 25 seconds after 8:13 P.M. eastern daylight time (EDT), which is 4 hours (-0400) behind Greenwich mean time. The message made its way via an ESMTP service (Extended SMTP is a version of Simple Mail Transport Protocol, the standard Internet sending protocol). The ESMTP service has an ID of UAA20703. The message ID identifies the message on this particular server. Each server gives the message a unique ID, which can be searched in the logs for that server if information

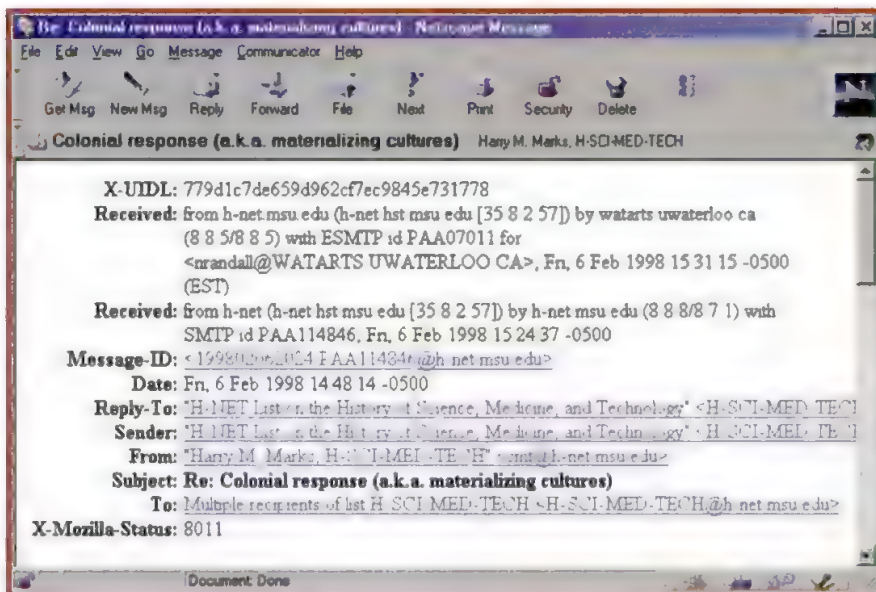


FIGURE 1: Netscape Messenger offers three header-viewing options. This is the normal view.

also help you track an improperly used e-mail account, perhaps someone who sends dangerous or threatening messages (or messages that breach company policy) or someone who floods your in-box with spam.

A mail header shows exactly how the message traveled across the Internet: where it started, which nodes it passed through, and how it got to your mail server. The path is rarely the same for any two messages, because

for that message is requested.

Note that the message is not actually annotated as finding its way to the recipient, *nrandall@watarts.uwaterloo.ca*. That's because the recipient's mail is stored on *watarts.uwaterloo.ca*, and he reads it from that machine. This is true even if (as is the case) he uses a mail program such as Outlook Express or Eudora Pro to download his mail to his local PC. The server *watarts.uwaterloo.ca*

does not actually relay the mail anywhere; it simply stores it for download.

The second header is also `Received:`. This one shows the earlier path of the message, and because it was a simple send from and to the same e-mail address, the path is obvious. The second `Received:` header shows that `vortex.uwaterloo.ca` received the message in the first place from the machine named `mmx166`, which has the name `kit-on2-29.netcom.ca`, and the IP `207.181.77.157` on the Internet provider Netcom Canada. This is the machine that originated the message. The SMTP ID in this case is `UAA21219`.

The `Received:` header is appended to the start of the message when the server receives it. Occasionally other headers will appear above the last `Received:` header. If, however, you see a header such as `Delivered to:` or `Return-path:`, it will be above the final `Received:` header. If you don't, there's a good chance the header has been forged by someone and then sent on to you. The forgery makes it impossible for you to reply to the message by using your client's usual reply feature. Spammed messages often have

mail software adds this information to the header at the time of composition. This header can also appear as `Mail-System-Version:`, `Mailer:`, or `Originating-Client:`. If the message is from a news-group program, this header will read `X-Newsreader`.

`Date:` shows the date, time, and time zone from which the message was sent, and the `From:`, `To:`, and `Subject:` lines are the same as those on the message. `X-UIDL:` is a message identifier for use with the sender's POP3 server. It is a long alphanumeric string that is always associated with that message and is never reused, even when the message is deleted.

MORE MESSAGE HEADERS

You'll find a wide range of headers in your messages, far too many to cover here in full. Instead, we'll examine several frequently appearing headers and what they tell you about

Spammed messages often have forged headers containing misleading information.

other recipients knowing about it (blind carbon copy). Note that the `bcc:` header will not appear in the message header on the mail clients of recipients who are not intended to see them.

`From:` is obviously the sender of the message, but you might also see `From` without the ending colon. The nonpunctuated `From` is used in the Unix mailbox (MBOX) format to designate that more than one message has been stored in a particular mail file. It is technically not a mail header at all. It is, however, a valid header

in a message sent from Usenet newsgroups, indicating the path the message has followed when traveling from Usenet to a mail host.

`MIME-Version:` tells you the version of the Multipurpose Internet Mail Extensions to which your message has been formatted. This is important to your mail client: If it can't handle that version of MIME, the message won't display correctly.

`Alternate-Recipient:` shows which recipients may receive the message if it can't be delivered to the recipient in the `To:` header.

`Sender:` identifies the e-mail address of the person who submitted the message to the network. Usually this is unnecessary, because the person in the `From:` header is the sender as well, but in cases where a "third-party" agent account is used, `Sender:` will appear. With `Sender:` is `X-Sender:`, which shows a third-party agent that cannot receive an e-mail address; it might be a root account message, for example. You might also see `X-X-Sender:`, which is used in place of `X-Sender:` because some e-mail software attempts to send to both `Sender:` and `X-Sender:`, but the latter is supposed to be an unreachable e-mail address. `X-X-Sender:` simply takes the `X-Sender:` function in this case.

`Newsgroups:` lists the newsgroups to which the message was posted. Cross-posted messages, of course, will show multiple newsgroups.

`Approved:` is another header originating in newsgroups. It tells you the name of the newsgroup's moderator, who had to supply permission for the message to be sent.

`Content-Type:` and `Content-ID:` work with MIME components of a message. The MIME type specifies the particular data type for a specific portion of a message. A common example is `text/plain; charset="us-ascii"`, which simply states that the message is in text format. `Content-ID:` offers a unique identification number for a part of the mes-

```
Received: from vortex.uwaterloo.ca (root@vortex.uwaterloo.ca
[129.97.42.40])
  by watarts.uwaterloo.ca (8.8.8/8.8.8) with ESMTP id UAA20703
  for <nranda11@watarts.uwaterloo.ca>; Mon, 22 Jun 1998 20:13:25 -0400
(EDT)
Received: from mmx166 (kit-on2-29.netcom.ca [207.181.77.157])
  by vortex.uwaterloo.ca (8.8.5/8.8.5) with SMTP id UAA21219
  for <nranda11@watarts.uwaterloo.ca>; Mon, 22 Jun 1998 20:13:23 -0400
(EDT)
Message-ID: <199806222014310510.024E90B0@artsmail.uwaterloo.ca>
X-Mailer: Calypso Version 2.40.41.04
Date: Mon, 22 Jun 1998 20:14:31 -0400
From: "Neil Randall" <nranda11@watarts.uwaterloo.ca>
To: nranda11@watarts.uwaterloo.ca
Subject: Tracking email headers
X-UIDL: b200ec868beefc53190d544978a930fa
```

FIGURE 2: This simple mail header shows a message sent from an account to itself.

forged headers. These contain misleading information usually produced either manually or through tampering with the SMTP server. (The various ways to spot forged or spammed headers is a topic for a future column.)

The header `Message-ID:` shows the unique ID number initially given to the message by the original SMTP server—in this case, `artsmail.uwaterloo.ca`. Again, this is a logging and tracking mechanism.

Next comes the header `X-Mailer:`, where you can see which e-mail program the writer used to compose and send the message. The e-

the message. The reason your mail program hides them is that they're typically of use only to your systems people and only when something goes wrong. But they're fascinating for their own sakes, if only so you can see in part how the e-mail process works.

`To:` is clearly the recipient's e-mail address, and is placed in the message at composition time. Also placed at that time are the `cc:` and `bcc:` headers. The former contains the addresses of additional (carbon-copied) recipients, and the latter shows the addresses of recipients who are copied without the

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OPTIMUM RESOLUTION	1280x1024	1024x768	1024x768
REFRESH RATE	85Hz/100Hz	85 Hz/100 Hz	85 Hz/100 Hz

MODEL	TVXL	TV	SV
CRT	17" MICROFILTER	17" MASK	17" MASK
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VIEWABLE AREA	16.0"	16.0"	15.9"
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```
Received: from watserv1.uwaterloo.ca
(root@watserv1.uwaterloo.ca [129.97.128.10])
  by watarts.uwaterloo.ca (8.8.8/8.8.8) with ESMTTP id
RAA24466
  for <nrandle@watarts.uwaterloo.ca>; Mon, 22 Jun 1998
17:39:28 -0400 (EDT)
Received: from LISTS.PSU.EDU (psuvm.psu.edu
[128.118.56.2])
  by watserv1.uwaterloo.ca (8.8.8/8.8.8) with SMTP id
RAA04100
  for <nrandle@WATSERV1.UWATERLOO.CA>; Mon, 22 Jun
1998 17:39:24 -0400 (EDT)
Received: from PSUVM.PSU.EDU by LISTS.PSU.EDU (IBM VM
SMTP V2R2)
  with BSMTTP id 3223; Mon, 22 Jun 98 17:33:13 EDT
Received: from LISTS.PSU.EDU (NJE origin
LISTSERV@PSUVM) by PSUVM.PSU.EDU (LMail V1.2c/1.8c) with
BSMTTP id 2741; Mon, 22 Jun 1998 17:33:13 -0400
Received: from LISTS.PSU.EDU by LISTS.PSU.EDU
(LISTSERV-TCP/IP release 1.8c)
  with spool id 4080 for CRTNET@LISTS.PSU.EDU;
Mon, 22 Jun 1998
  17:33:10 -0400
Received: from PSUVM (NJE origin SMTP@PSUVM) by
```

```
PSUVM.PSU.EDU (LMail
  V1.2c/1.8c) with BSMTTP id 2701; Mon, 22 Jun
1998 17:33:09 -0400
Received: from VAX.NATCOM.ORG (38.183.103.2,2330) by
PSUVM.PSU.EDU (IBM VM SMTP
  V2R2) with TCP; Mon, 22 Jun 98 17:33:06 EDT
Received: from WS08.natcom.org by VAX.NATCOM.ORG (MX
V4.1 VAX) with SMTP; Mon,
  22 Jun 1998 17:32:54 EDT
X-Mailer: Microsoft Internet E-mail/MAPI - 8.0.0.4211
MIME-Version: 1.0
Content-Type: text/plain; charset="us-ascii"
Content-Transfer-Encoding: 7bit
Approved-By: CRTNET News <crtnet@NATCOM.ORG>
Message-ID:
<710526B372E6D011886702608CDD295F123079@www.natcom.org>
Date: Mon, 22 Jun 1998 17:32:47 -0400
Reply-To: CRTNET News <crtnet@natcom.org>
Sender: Communication Research and Theory Network
<CRTNET@LISTS.PSU.EDU>
From: CRTNET News <crtnet@natcom.org>
Subject: #3002: Announcements and queries
To: CRTNET@LISTS.PSU.EDU
```

FIGURE 3: A more complicated header details the route the message took from sender to destination and other pertinent information.

sage. This is especially applicable to messages containing embedded HTML coding or other MIME components.

List-Unsubscribe: specifies an e-mail address to which you can send an unsubscribe message for a mailing list. Ideally, all mailing lists will have this information, but it's not required. Other possible mailing list headers are **List-Subscribe:**, **List-Owner:**, and **List-Archive:** (which shows the URL for the list's message archive), and others. All are fairly obvious.

X-Priority: gives a numerical rating for the degree of priority given the message, with 1 meaning highest priority and 5 meaning lowest. The writer of the message sets this parameter through the options available in the e-mail client. Related headers can include **Importance:**, which is pretty much the same thing, and **Sensitivity:**, which tells the recipients how confidential the message is. Again, these headers are inserted by the client software, not by a server (which obviously couldn't know any of this).

PICS-Label: contains the advisory (that is, censorship) rating suggested by the PICS standard. This is established at the time of message composition.

Encoding: varies according to the e-mail system, but essentially it's a cue to the receiving software to interpret and display the data

correctly. It can also be used simply as a substitute for **Content-Type**, but the latter is gaining precedence.

Resent-x: contains information about message forwarding by the server. The **x** component can be a range of possibilities, so the actual header will read **Resent-From:**, **Resent-cc:**, **Resent-bcc:**, and so on.

ANOTHER READ-THROUGH

To see how all of this works, let's look at a more complex message header, shown in Figure 3. This one is from the mailing list of the Communication Theory and Research Network, better known as CRTNET.

First, we'll determine the path of the message itself by starting at what is chronologically the first **Received:** header. In this case, it's the eighth such header from the top, **Received: from WS08.natcom.org** and so on. The server **WS08.natcom.org** received the message at 17:32:54 EDT and passed it to **VAX.NATCOM.ORG**, which received it at 17:33:06 EDT. From there, the message went to the **PSUVM.PSU.EDU** to start its mailing list (listserv) life, and thence through the listserv software (**LISTSERV-TCP/IP release 1.0c**) at **LISTS.PSU.EDU**, at 17:33:10 EDT (4 seconds after reaching the Vax machine at **natcom.org**). From here, it went through the **LISTSERV** address at the server **LISTS**

.PSU.EDU, through another **PSU.EDU** server, and finally to **watserv1.uwaterloo.ca**, where it was received for the user **nrandle@watserv1.uwaterloo.ca**. As it happened, this user had his mail from that account forwarded (via a UNIX **.forward** file) to his main account at the server **watarts.uwaterloo.ca**, which received the message in the top **Received:** header, at 17:39:28.

The other header information reads as follows, following down the lines. The message was sent from the e-mail program **Microsoft Internet E-Mail (Internet Mail)**, and the message is in MIME format (Version 1.0 of MIME). Its content type is simple ASCII text, and it passed through and was approved for sending by the account **crtnet@NATCOM.ORG**, the same as the **Reply-to:** address and the **From:** address in the header lines further down. The message has a lengthy specific ID, and it was sent at 17:32:47 EDT (-0400, or 4 hours before GMT). The sender was the mailing list **CRTNET@LISTS.PSU.EDU**, and the subject of the message was **#3002: Announcements and queries**.

Nothing to it, right? **PC**

*Neil Randall is the author of **The Soul of the Internet (ITCP)** and **Special Edition Using Microsoft FrontPage 98 (Que)**.*

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CrackUp Alerts You to Disk Fragmentation

This issue's free utility lets you know when your hard disks need to be defragmented.

By Gregory A. Wolking and Bob Flanders

Disk fragmentation degrades hard disk performance over time. When files are not stored contiguously on the disk, the read/write head has to reposition itself frequently, and this takes time. Thus periodically defragmenting your hard disks is a good idea, and Windows comes with a utility to do this called Defragmenter.

Defragmenting a hard disk takes some time, so it's not something you'd want to do unnecessarily. However, the version of Defragmenter that comes with Microsoft Windows 98 does not report whether your hard disk needs defragmenting, and the Windows 95 version of Defragmenter has very limited reporting. When you select *one* drive, the Windows 95 Defragmenter will report a fragmentation percentage if the drive does not need defragmenting. But if you select multiple drives, the process will start immediately without a report. In addition, the calculation method of the Windows 95 version of Defragmenter is faulty. It often reports that a drive is not fragmented when the drive really is.

CrackUp, which runs under both Windows 95 and Windows 98, addresses all of these drawbacks and adds features of its own. It accurately calculates the fragmentation percentage, and it reports the fragmentation of all local hard disks in a single window. It also can run in the background to check fragmentation at intervals, and it can warn if any disk exceeds the specified fragmentation level. If

you want the raw fragmentation data, you can generate a detail report in text or comma-separated values (CSV) format.

You can obtain CrackUp by download from PC Magazine Online or by mail. Refer to the sidebar "Getting the Files" for details. The source code for CrackUp, which was

touch the system registry. The only files it creates are CrackUp.ini, stored in the same directory as CrackUp.exe, and the detail report, stored in the location of your choice.

CrackUp's main window is a two-page property sheet. The *Report* page (see Figure 1) displays the fragmentation percentage for each selected drive and lets you generate detail reports. The *Configure* page (see Figure 2) is where you set CrackUp's operating parameters.

Since CrackUp can do background scans, it places an icon in your system tray. Double-click the icon to open CrackUp's main window; right-click to open a pop-up menu. If CrackUp is displaying a window or message box, double-clicking or right-clicking on the tray icon will bring that window or message box to the foreground. You can use the pop-up menu to activate CrackUp's main window, scan immediately, access online help, or exit the program.

The first time you launch CrackUp, it will ask whether you want to open the *Configure* page. Answer yes; CrackUp will open with that page selected. You don't have to select any drives, but if you don't, CrackUp will ask that question every time you activate the main window.

The *Drives to Check* list on the *Configure* page shows all the disk drives that CrackUp can monitor—local hard disks using either the FAT16 or the FAT32 file system. Check the box next to each drive letter that you want CrackUp to monitor. The *Enable background scanning* check box determines whether CrackUp will scan at the interval specified. Whenever background operation is selected, CrackUp displays the amount of time remaining until the next automatic scan at the bottom of this section of the dialog. To minimize background processing time, CrackUp updates this display every 10 seconds instead of every second.

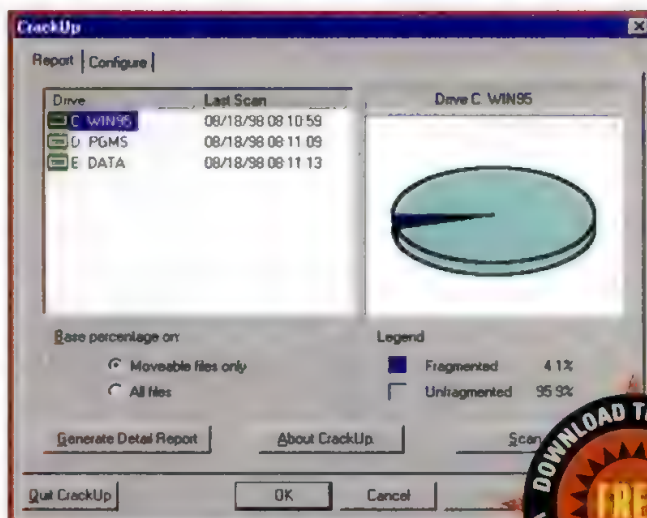


FIGURE 1: CrackUp's Report page displays the percentage of fragmentation for each selected drive and lets you generate detailed reports.

written with Microsoft Visual C++ 5.0 and Microsoft Foundation Classes (MFC), is also provided for programmers interested in seeing how it works.

USING CRACKUP

To install CrackUp, place its component files (CrackUp.exe, CrackUp.hlp, and CrackUp.cnt) into any folder, then create a shortcut to CrackUp.exe. To remove the program, simply delete the files. CrackUp does not

For Programmers Only CrackUp is a tray application written in C++ with Microsoft Foundation Classes (MFC). It can be compiled with Microsoft Visual C++ 5.0. The full source code for CrackUp is available from PC Magazine Online (www.pcmag.com/pctech) and demonstrates several interesting programming techniques, including how to

- access low-level disk information;
- create a hidden main window;
- draw pie charts.

Support Help for PC Magazine's free utilities can be obtained in our online discussion areas, both on the World Wide Web (www.pcmag.com/discuss.htm) and on ZDNet in the Utilities section of ZDNet's Tips Forum (GO ZNT:TIPS). The authors of current utilities generally visit this forum daily. You may find an answer to your question simply by reading the messages posted in the forum. If the author is not available and the forum sysops can't answer your question, the Utilities column editor, who also checks this forum each day, will contact the author for you.

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The *Alert Parameters* settings determine whether CrackUp will present its alert after each scan, what the threshold level is for that alert, and which fragmentation formula to use (more on that later).

Click the *OK* or *Apply* button to save your settings. Whenever you change your drive selection or settings, CrackUp will ask whether you want to scan immediately. If you decline, it will not scan until the background timer expires.

Once you have configured CrackUp, its behavior when launched depends on whether background operation is enabled. If so, CrackUp launches quietly, placing its icon in the system tray. It will start scanning approximately 10 seconds later; the tray icon is animated during the scan. If you activate the main window, the *Report* page will not show any data until the first scan is completed. CrackUp will perform subsequent scans at the interval you specify, with no further messages unless the alert feature is triggered. If background operation is disabled at start-up, CrackUp will scan all selected disks immediately and display the *Report* page. When you close the window, CrackUp remains available in the tray but will not scan until you tell it to.

The *Drive* list on the *Report* page shows all selected disks, their volume labels, and the date and time each was last scanned. Select a disk to view its level of fragmentation. CrackUp will update the pie graph and legend fields accordingly. The *Scan now* button tells CrackUp to scan immediately. If a background scan begins while the main window is open, CrackUp will update the display when the scan finishes. The *Generate Detail Report* button opens the *Save Report As* dialog (more on this later).

The *Apply* button (enabled only if you have changed settings in the *Configure* page) activates your new settings and leaves the main window open. The *OK* button saves your changes and hides the window. The *Cancel* button hides the window and discards changes. The *Quit CrackUp* button terminates the program.

If you prefer not to have CrackUp remain resident, you can use it in quick-scan mode. When you launch CrackUp with the */quick* parameter on the command line, it will scan all selected disks immediately, then open the main window with the *Report* page selected. You may work with the *Report* and *Configure*

pages as usual, but when you close the window, CrackUp will terminate.

CRACKUP'S REPORTS

The fragmentation percentages give a good index of the condition of your disks, but they can't tell you everything you might want to know. For this reason, CrackUp offers a detail report, which you can generate in either plain-text or CSV format. When you click the *Generate Detail Report* button, you'll see a *Save Report As...* dialog, where you can enter the name and location of the report file. Your selection in the *Files of Type* list determines the format of the report. Select *Text files (*.txt)* to generate a plain-text report or *Comma-separated values (*.csv)* to generate a CSV file.

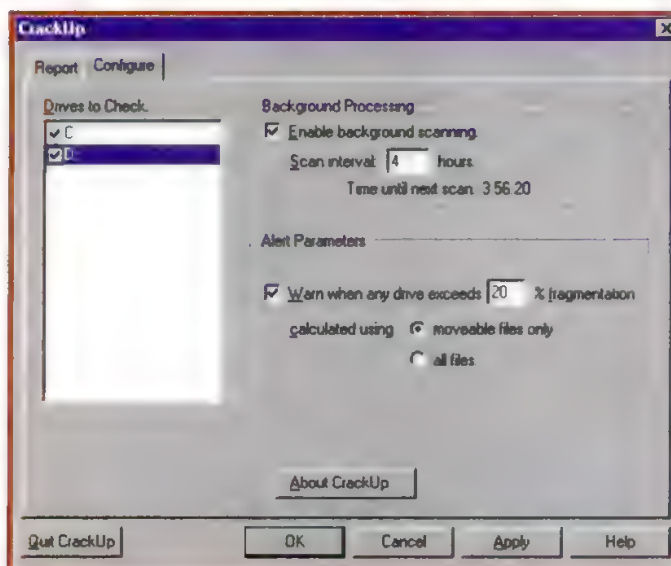


FIGURE 2: The *Configure* page is where you set CrackUp's operating parameters.

If you check *Include column headers*, the first line of a CSV file will contain the text headers for all the columns. The *Launch report* check box instructs CrackUp to launch your report using the associated application. The *Save Options* button saves your check-box and file-format settings.

If you just want to export the fragmentation percentages, CrackUp provides a quicker method. Right-click the *Drive* list, or tab to it and press Shift-F10, then select *Copy results to the clipboard* from the context menu. Each line copied to the clipboard will contain a drive letter, the date the disk was scanned, and fragmentation percentages based on movable files only and on all files.

COMPUTING FRAGMENTATION

Percent fragmentation may sound like simple calculation—it's just a percentage, after all—but the process is anything but simple. There

are many ways to quantify fragmentation, and determining the right formula was the most difficult challenge in writing CrackUp. We wanted to use the percentages reported by Windows 95's Defrag as a check but discovered that Defrag had serious calculation flaws. In the end, we came up with a formula that matched Defrag except when Defrag was obviously incorrect.

When a file is stored in a contiguous series of clusters and in the correct order, the file is *unfragmented*. As you erase and add files, however, files can become fragmented. Say you erase a file from the beginning of your hard disk and then later save another, larger file. The operating system may put part of the new file where the old, deleted file was, and it

may put the rest of the file in another location where there is space. This causes the file to be *fragmented*. If many files on a disk are fragmented, system performance will improve if you *defragment* your disk so that all the files again are stored contiguously.

The problem is how to compute a reliable index that can tell you when your disk needs defragmenting. For starters, the computation cannot be based on the number of fragmented files. A disk containing 1 huge file in 80 pieces is much more fragmented than a disk containing 1 small file in 2 pieces. So our computation is based on the number of fragments rather than the number of fragmented files.

Let's define terms. In this discussion, a *subdirectory* (and the

root directory on FAT32 partitions) is equivalent to a file, because a subdirectory is just a special type of file that holds information about other files and directories. Each file consists of zero or more clusters. Zero-length files do not affect fragmentation and are excluded from the calculations.

Each contiguous portion of a file's cluster chain is called a *fragment*. An unfragmented file consists of a single fragment; a fragmented file consists of two or more fragments. By definition, the first portion of a file's cluster chain (its first fragment) is not fragmented. Therefore a disk can never be 100 percent fragmented. Fragments beyond the first are called *extra fragments*. The more extra fragments, the more fragmented the file. A file is maximally fragmented when the number of fragments equals the number of clusters. In other words, each of that file's fragments consists of a single cluster.

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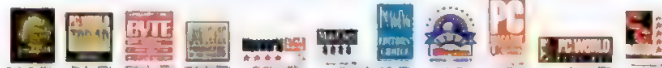
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CrackUp also considers free space when calculating fragmentation. Contiguous regions of free space can occur at the physical ends of the disk (*unbounded free space*) or between allocated fragments (*bounded free space*). Bounded free space is, by definition, fragmented. Since we're concerned only with the portion of the disk that's actually being used to store files (that is, the space from the first to the last allocated cluster, inclusive), we exclude unbounded free space from our calculations. If we did not, the reported fragmentation level would be artificially low, especially if the disk were not very full.

Percentage of fragmentation for all files is calculated as follows:

```
((extra fragments + bounded free
fragments)/(total clusters - unbounded
free clusters)) * 100
```

There is one last factor: Windows' Defrag considers certain files to be unmovable. This includes any files with both the hidden and system attributes set, along with the system swap file. Since Defrag won't defragment these files, you may wish to exclude them from the overall calculation. The percentage of fragmentation for movable files only is calculated this way:

```
((movable extra fragments + bounded
free fragments)/(total clusters -
unbounded free clusters - unmovable
clusters)) * 100
```

CrackUp is strictly a reporting tool. When it warns that a disk is excessively fragmented, you must use a separate utility such as Defrag to defragment your disk. Note also that Windows 98 doesn't just defragment FAT32 disks, it optimizes them. This optimization includes monitoring the way that executable files are loaded, then rearranging their clusters in the order that they are actually loaded, possibly fragmenting them so they can be loaded more rapidly. As a result, optimizing your FAT32 drives in Windows 98 may actually *increase* the fragmentation that CrackUp reports. Under Windows 98, CrackUp's alerts are useful only for FAT16 drives and for FAT32 drives that contain few executable files.

INSIDE CRACKUP

To gather the information it needs, CrackUp must be able to read disk sectors directly. It does so using the system's VWIN32 virtual device driver to call the necessary DOS (that's right, DOS!) functions. This device driver is

not available under Windows NT, which is why CrackUp works only under Windows 95 and Windows 98.

Direct disk reads are performed by one of two functions, either `OldReadSectors` or `NewReadSectors`, depending on your Windows version. For Windows 95 OSR2 and later, `NewReadSectors` uses INT 21H function 7305H, which supports the FAT32 file system. For previous versions, `OldReadSectors` uses INT 25H.

At start-up, CrackUp obtains a list of all local FAT16 and FAT32 hard disks. It then calls the `CheckFrag` function to scan each eligible disk. Using the disk's BIOS Parameter Block (BPB) to locate the FAT, it reads the FAT into memory and calls `CountFreeSpaces` to tally free-space statistics. Next it calls the `DrvAnalyze` function to analyze file fragmentation.

Starting with the root, `DrvAnalyze` loads a directory's clusters into memory and examines each directory entry. If an entry represents a file, `DrvAnalyze` passes the file's first cluster to `AnalyzeChain`, which records the file's fragmentation. For a subdirectory entry `DrvAnalyze` calls itself recursively, passing the number of the subdirectory's first cluster, and then analyzes the subdirectory just as it would any other file. Since `DrvAnalyze` reads each FAT and directory sector from disk only once, and clusters allocated to files are never read at all, disk access is minimized.

A HIDDEN MAIN WINDOW

We wrote CrackUp with Microsoft Visual C++ 5.0, and we used the App Wizard to generate the basic skeleton application. With the App Wizard, you must choose between the document/view architecture, which uses a standard frame window as the main window, and the dialog-based architecture, which uses a modal dialog box as the application's main window.

Since CrackUp doesn't manage documents, the document/view architecture is inappropriate, because it bloats the program with code that will never be used. The dialog-based architecture isn't ideal either, because CrackUp's main window is never used for direct user input and doesn't need to be visible.

Therefore, we had four options. We could ignore MFC and write the entire application from scratch. We could construct a document/view application and manually remove the document-management code. We could construct a document/view application and base the main-window class on `CWnd` instead of the default `CFrameWnd` with all its overhead. Or we could construct a dialog-based application and modify it to make the main window invisible. This last option required the least work

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while retaining the ease of use that the MFC framework provides.

In a standard MFC dialog-based application, most of the action occurs in the application object's `InitInstance` function. `InitInstance` creates the application's dialog object on the stack as a local variable, then calls the object's `DoModal` function to display the dialog, which handles all further user input. When the dialog closes, `DoModal` returns and `InitInstance` returns `FALSE`, telling the application to terminate. Since the dialog object was created as a local variable, it is destroyed automatically when execution leaves the `InitInstance` function.

If you need your program's main window to be hidden during start-up, you have to jump through a few hoops, because MFC's `DoModal` function forces the window to be initially visible. To avoid this, you must either write your own override of `DoModal`, one that doesn't force the window to be visible, or add code to your `OnInitDialog` handler to hide the dialog after it has been created. Overriding the function makes your code fat, because you must duplicate a large section of code just to change one small aspect of its operation. Hiding the dialog after creation requires much less code, but the dialog will flash on the screen as the application starts. Using a modeless dialog as CrackUp's main window solves these problems without these undesirable side effects.

Since CrackUp's main hidden dialog must exist throughout the lifetime of the application, we declared the single `CCrackUpDlg` object as a global variable (`g_dlgMain`) instead of as a local variable within `InitInstance`. `CCrackUpApp::InitInstance` uses `g_dlgMain` to call the object's `Create` member function instead of `DoModal`. This creates the object and its associated dialog window. Since our dialog's template does not have the `WS_VISIBLE` style and the `Create` function (unlike `DoModal`) doesn't force that window style, the window is not displayed on the screen.

Once we created the main window, we set the `m_pMainWnd` member variable to point to the dialog's window and then have `InitInstance` return `TRUE`. Thus, the application

continues to run using the dialog as the main window. When it's time for the program to end, we call the `CCrackUpDlg::DestroyWindow` function to destroy the modeless dialog. When we do, the MFC internals take care of posting a `WM_QUIT` message to the application's message queue, causing the application itself to terminate.

DRAWING PIE GRAPHS

Early incarnations of CrackUp drew the pie graph directly to the screen. This had undesirable side effects, such as the graph flickering as another window moved across it, or portions of the graph not being colored in properly when the graph was partially obscured by another window.

If you need your program's main window to be hidden during start-up, you're going to have to jump through a few hoops.

To solve these problems, we created the `CPieGraph` class, derived from the `CStatic` class, which is normally used to interface with a static control. `CPieGraph` contains all of the code and logic necessary to draw a simple two-slice 3-D pie graph in a static Picture control's client area. We designed `CPieGraph` as a separate component to isolate the display of data from the gathering and analysis of data. This ensures that changes to the analysis routines won't have hidden side effects in the display. Also, if we later want to substitute a different, more sophisticated component, we can do so simply by using the same member variables and functions.

CrackUp's report dialog includes a `CPieGraph` object called `m_boxPieChart`. On initialization, the dialog sets four member variables of type `COLORREF` to the desired colors for different elements of the chart. The primary slice gets its color from the variable `m_crPrimary`, the secondary slice from `m_crSecondary`, and the background from `m_crBackground`. The variable `m_crLines` sets the color used to draw the outline of the pie and the dividers between the slices. Each of the colors must be different.

Changing these variables has no visible effect until you call the `SetPercentage` member function, which sets the percent used to draw the first slice (the size of the second slice is set automatically) and regenerates the graph. This approach lets you set the colors before the graph has been drawn for the first time. Initially, the percent is set to 0. Later, CrackUp passes the actual percentage to `SetPercentage`. Note that the call to `SetPercentage` must come after the call to `OnInitDialog` to ensure that the windows for the dialog and all of its controls have been created.

For completeness, `CPieGraph` provides two versions of `SetPercentage`. One takes a float between 0.0 and 1.0. The other—the one CrackUp uses—takes an integer between 0 and 100. If either receives an argument that's out of range, `SetPercentage` returns without updating the graph.

Defragmenting your hard disk takes some time, so it's not something you want to do needlessly. CrackUp tells you when your hard disks really need defragmenting and gives you detailed information on the condition of your disks that is not available elsewhere. **PC**

Gregory A. Wolking is the primary sysop of the ZNT:Tips Forum on ZDNet/CompuServe and the PC Magazine Utilities discussion area on the Web. Bob Flanders is a senior software architect for EJBell Systems in Fairfax, Virginia. He specializes in telecommunications software and World Wide Web applications design and implementation. Sheryl Canter is the editor of the Utilities column and a contributing editor of PC Magazine.

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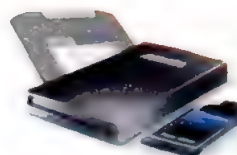
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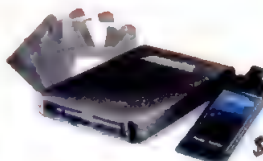
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User-to-User

BY NEIL J. RUBENKING

Automating Deletions from The Windows 95 Registry

In the November 4, 1997, *User-to-User* column, reader Roy Lehrer showed how specific keys or values in the registry could be deleted using an INF file. The INF file can be "launched" in a couple of ways—by right-clicking the file in Explorer and selecting *Install* from the right-click menu, or by creating a shortcut to the file on the desktop and double-clicking its icon. (The latter method requires that "Install" be made the default action for files having the .inf extension.)

Building on these techniques, I created a file called *Delurl.inf* (Figure 1) which deletes the registry key *URL History* created by Netscape Navigator. This key contains the names of all URLs the browser has visited. (The full path is *HKEY_CURRENT_USER\Software\Netscape\Netscape Navigator\URL History*.)

In the registry, keys are analogous to folders, and values are analogous to files contained within folders. Just as deleting a folder will delete all the files it contains, deleting a registry key will delete all values associated with the key. In this case, deleting the *URL History* key will delete all its values—the list of visited URLs. You don't need to know the name of each specific URL.

The trick to launching an INF file from within a batch file—as you have suggested—is to precede the name of the file with the internal command associated with Windows 95's "Install" action. The name of the INF file can then be used as the command's argument. The internal command can be identified and inserted into a batch file in the following way:

Open Explorer. Click *View*, then *Folder Options*, then the *File Types* tab. A window listing all registered file types will appear. Scroll down to the item called *Setup Information*. Highlight that item, then click the *Edit* button. In the resulting *Actions* window, highlight *Install*, then click the *Edit* button. This opens a window called *Editing Action* for type: *Setup Information*. In the text box called *Application* used to perform action, you will see the highlighted command that defines Windows 95's "Install" action, which will look very much like this:

```
c:\windows\rundll.exe
setupx.dll,InstallHinfSection
DefaultInstall 132
```

Be careful not to strike a key accidentally at this point, or the entire highlighted string will be deleted! Copy the string to the Clipboard using *Ctrl-C*. Then repeatedly press *Cancel* to get out

of Explorer. Open a batch file from which you want to launch your INF file, and paste the string at the beginning of a new line. At the end of the line, leave a space after the string, then type the full pathname of the INF file you want to launch.

When you run the batch file, it will execute the INF file. In this particular example, it will execute *Delurl.inf*, which deletes from the registry the *URL History* key (and therefore all its associated values—the list of visited URLs). This won't cause any problems for the browser. The *URL History* key is simply re-created automatically the next time the browser is launched.

The INF file shown here will work for the 32-bit version of Netscape Navigator 3.x. (The 16-bit version does not store a list of URLs in the registry, but rather in the *Netscape.ini* file.) Using this technique, you could easily create an INF file for Netscape 4.x or Internet Explorer 3.x or 4.x.

JEFF MENKES

Farmington, Connecticut

PC MAGAZINE: It's simple enough to automate the process of adding information to the registry. You start by creating a REG file, either by exporting existing information using *RegEdit* or by very carefully building it from scratch. To launch the REG file within a batch file, you prefix its name with *Regedit /S*. The */S* switch tells *RegEdit* not to display a message box.

The earlier item referenced above, "Remove Entries from the Windows 95 Registry Automatically," can be found at www.pcmag.com/pctech/content/solutions/uu1619a.htm. It explains in detail how to create INF file entries that delete entire registry keys or particular values within a key. In addition, it provides a sample INF file that deletes history lists for a large num-

```
:DELURL.INF
:When "installed," this file
:deletes the "URL History" key
:in the Win 95 Registry and all
:values (URLs) associated
:with it.
[version]
signature="$CHICAGO$"
[DefaultInstall]
DelReg=EraseThis
[EraseThis]
HKCU,"Software\Netscape\
Netscape Navigator\URL History"
:HKCU is Win 95 shorthand for
:Hkey_Current_User
```

FIGURE 1: This sample INF file deletes the URL history for 32-bit Netscape 3.x.

ber of common applications. If this topic interests you, be sure to read that article as well.

But activating that INF file still required direct user interaction—you had to right-click it and choose *Install* from the pop-up menu. Now we see that it's possible to locate and copy the command invoked by that *Install* menu item, thereby gaining the ability to automate launching an INF file. Using carefully crafted INF files to delete keys and values and REG files to add them, you can build batch files that make important changes to the registry without ever launching the powerful (and dangerous) *RegEdit* program.

Edit IE4 Link Names

One of the really cool features of Internet Explorer 4 is the ability to drag an address from the Web right onto your Links toolbar to make a permanent icon. Unfortunately, though, there's no way to edit and change the icon's name once you get it on the bar, and some of the site names are really long and obscure. Here's a quick and dirty workaround.

Start by dragging the address out of the address bar and onto your desktop. Then edit the name as you would any other icon. When you're done, drag it onto the Links toolbar in IE4. Nice and easy! This way you can have 12 or so of your favorite Web sites only a short click away.

SHAWN GAMBLE
Overland Park, Kansas

PC MAGAZINE: If you drag a couple of your favorite *User-to-User* tips from the *PC Magazine* site to your IE4 Links bar, you'll find that that one or two names, like *PC Magazine - Solutions (Personalize Your Windows 95 Start Menu)*, occupy the entire width of the bar. It's definitely worthwhile to shorten these names as much as possible. After you've edited the title as explained above, you'll need to delete the original link (with its overlong title). Just right-click it and choose *Delete* from the menu. You'll also want to delete the extra icon from the desktop.

You can circumvent the need to edit Links items by dragging the URL you want to save onto the desktop in the first place. Edit the title of the icon on the desktop, then drag it to the Links bar and get rid of the redundant copy on the desktop. One more thing: If you want to put the current page on your Links bar, don't try to drag the text of the URL from the Address box. Instead, drag the icon that's at the left of the URL.



Ask Our Advisors

HARDWARE

Bus Transfer?

I have an older 486 that I'm scrapping. I'd like to give a friend the VLB (VL-Bus) card that's in it to install in her new computer. She lives 400 miles away, so I can't look to see the slots or read the manuals, but apparently her system has only PCI and ISA slots. Is there any hope of installing this card in her system?

TROY BEKKER
via the Internet

PC MAGAZINE: The simple answer is that your friend is out of luck on this one. VLB and PCI are very different, and you cannot get one to connect with the other.

VLB was an attempt to create a standard 32-bit connection directly into the computer's system bus, which meant that the CPU could write to devices at the full system speed—up to 33 MHz. This was a perfect match for 80486 processors, which had system clocks that ran up to that speed.

For the Pentium a different arrangement was needed, because the system clock speeds ranged from 50 to 66 MHz, too fast for expansion cards at that time. Also a 32-bit interface, PCI is designed as a “mezzanine” bus, which is separated from the system bus and runs at its own speed. For most systems, this is 33 MHz, though the PCI specification does provide for a 66-MHz configuration. Even though PCI and VLB cards are both 32-bit and operate at 33 MHz, there is no way that you can use one in a slot designed for the other. Even if you had a way to connect the two physically (the slots are different sizes and configurations), the two designs would still have different signals.

If you want to provide your friend with a PCI graphics card, your best bet is to try to sell the 486 system. PCI graphics cards are relatively inexpensive these days, and for the price you might get for the system, you should be able to purchase a new PCI graphics adapter that will outperform your older VLB card.

—Alfred Poor

OPERATING ENVIRONMENTS

Recovering from a Lost Password

At my school, I help many of the teachers and students use our new PCs, because the Director of Technology is mostly a Mac user. One of the

staff members in charge of the monthly newsletter types his important documents in Microsoft Word and then password-protects them. Unfortunately, he forgot the password, and he really needs the files back. Is there any way to remove the password-protection from those files?

JAMIE GREATA
via the Internet

PC MAGAZINE: In truth, very little security is gained by password-protecting documents using the password feature built into most popular word processors. You can find password-cracking utilities such as Word for Windows Password Cracker (Wfwd.exe) on a wide variety of download sites; that will solve your immediate problem. Then pay a visit to the site http://spider.bokler.com/bokler/bsw_crak.html for an eye-opening list of utilities that will break the password-protection built into a variety of programs.

Unless you use an industrial-strength program designed specifically for encryption, your password-protected files are probably not as safe as you imagined. If files are really private, a better idea might be to store them on a floppy disk and lock them in the safe at night!—Neil J. Rubenking

WORD PROCESSING

Turning Off Table Borders in Microsoft Word 97

When Word 97 inserts a table, it automatically adds borders—both to the outside of the table and to all cells—instead of simply showing gridlines, which was the default in earlier versions of Word. Is there any way to turn this feature off if you don't want borders? I find it annoying to have to select the table each time and then work my way through clicking on the Tables and Borders button, then the arrow next to the Outside Borders button, and finally the No Border button.

MARK THOMAS
via ZDNet

PC MAGAZINE: Unfortunately, Microsoft added the default table borders without providing a way for you to change them. And the new default applies whether you use the Table | Insert Table command, the Insert Table button, or the new Draw Table tool on the Tables and Borders toolbar. The default setting for the border lines is 0.5 point, which

may not be what you want even if you use borders.

The good news is that there are less cumbersome ways to turn off the borders than selecting the table and working your way through the toolbars. In fact, you don't even have to select the table. If your cursor is anywhere inside the table—which it will be immediately after you use the Insert Table button or the Table | Insert Table command—you can remove the lines by choosing Table | Table AutoFormat, selecting (none) in the list of formats, and then choosing OK.

You can reduce these four steps to one by recording them in a macro. To record the macro, first insert a table with either the menu or the toolbar-button command. The cursor should automatically go to the upper-left-hand cell of the table. Then choose Tools | Macro | Record New Macro, and enter an appropriate name for the macro, such as RemoveBorders.

Once you've optionally assigned a keyboard shortcut or toolbar button to the macro and you've returned to the document, choose Table | Table AutoFormat, select (none) in the Formats list, choose OK, and

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PCTech Ask Our Advisors

choose **Tools | Macro | Stop Recording** or click on the **Stop Recording** button. You should now be able to insert a table and then remove the border by running the macro. If you've attached the macro to a keyboard shortcut or toolbar button, the extra step should be reasonably painless.

If you prefer using the **Draw Table** tool for creating tables, you can use the same techniques to remove the borders. But you can also easily turn off borders before adding the table.

To open the **Tables and Borders** toolbar, click on the **Tables and Borders** button in the standard toolbar or put a check mark by the menu item **View | Toolbars | Tables and Borders**. Select **No Border** in the **Line Style** drop-down list, then click on the **Draw Table** tool and draw your table—without borders. Word will not retain the **No Border** setting after you close the program, but it will retain the setting for the rest of the session. If you record the setting in a macro and name the macro **Autoexec** (or copy the command into an existing **Autoexec** macro), it will run every time you start Word. But keep in mind that this will eliminate borders only for tables and cells inserted with the **Borders** toolbar.

—M. David Stone

SPREADSHEETS

Counting Occurrences of Entries in Excel Ranges

The Excel function **COUNT(A1:A15)** counts the number of numeric entries in the range A1:A15. The function **COUNTA** appears to do the same thing except that it includes nonnumeric entries and allows additional arguments. The additional arguments appear to be a way to count occurrences of a specific entry. But I can't make sense out of the example in Excel's help file, and I can't get the function to count specific nonnumeric entries.

I want to count the number of < (less than) symbols in a column of entries that also contain periods and E's. However, no matter what symbol I put between the quotes, I still get 15 returned. In other words, the function returns the number of cells, not the number of < symbols.

If the function is designed to return the number of cells from the first address to the second, why are there 30 possible arguments? Doesn't it make sense that if **COUNT** returns the number of numbers, then **COUNTA** would count the number of things specified in the argument? What do I not get here?

PETE ROGERSON
via the Internet

PC MAGAZINE: The examples in Excel's help file are needlessly confusing. First of all, both **COUNT()** and **COUNTA()** accept up to 30 arguments. So, for that matter, do **SUM()**, **AVERAGE()**, and several other everyday Excel functions. In all cases, the first argument is required and the other 29 are optional. The additional arguments simply let you apply the functions to multiple ranges. You could, for example, write a **COUNT** formula that looks like this:

```
=COUNT(A1:A15, B30:C42, D10:D100)
```

In this example, **COUNT()** has three arguments, and the function returns the total number of numeric entries in the ranges A1:A15, B30:C42, and D10:D100.

The arguments do not have to be ranges. They can be single cells. They can also be constants "hard-coded" into the formula. It would be perfectly legal (if not very useful), for example, to write,

```
=COUNT(2)
```

This function would return 1, because 2 is a number.

Excel's peculiar help text for **COUNTA()** gives the following examples of how the function may be legally used:

```
=COUNTA(A1:A7)
=COUNTA(A4:A7)
=COUNTA(A1:A7, 2)
=COUNTA(A1:A7, "Two")
```

Because the third and fourth examples use constants as second arguments to **COUNTA()**, Mr. Rogerson drew the not entirely unreasonable conclusion that the second argument provided a conditional criterion—that **=COUNTA(A1:A7, 2)** specified counting up all the 2s in A1:A7 and **=COUNTA(A1:A7, "Two")** specified counting the cells in A1:A7 that contained the text string "Two."

In fact, the examples were intended to help users distinguish between the effects of **COUNT()** and **COUNTA()**. The difference between these functions is that **COUNT** tallies numeric entries only, while **COUNTA** counts all nonblank entries, including text, error values, and logical values. So, assuming A1:A7 all contain numbers, **=COUNT(A1:A7, "Two")** returns 7, while **=COUNTA(A1:A7, "Two")** returns 8.

So if **COUNTA()** can't be used to count conditionally, what can? If the condition involves only one criterion, the answer is **COUNTIF()**. To count all the values in A1:A15 that are equal to 2, for example, you can write:

```
=COUNTIF(A1:A15, 2)
```

Here are some other ways you can use **COUNTIF()**:

```
=COUNTIF(A1:A15, "Two")
```

returns the number of entries in A1:A15 that contain the text string "Two."

```
=COUNTIF(A1:A15, ">500")
```

returns the number of entries in A1:A15 that are greater than 500.

```
=COUNTIF(A1:A15, H1)
```

returns the number of entries in A1:A15 that meet the criterion specified in H1.

So now if Mr. Rogerson wants to count up all the cells in A1:A15 that contain the less-than symbol, he should be able to write,

```
=COUNTIF(A1:A15, "<")
```

Right? Wrong! That would be too easy! In this formula, Excel refuses to treat "<" as a piece of text. Instead it construes the symbol as some sort of mutant comparison—less than blank, perhaps. And there is no way that I have discovered to make **COUNTIF** tally the cells that contain a bare less-than symbol.

Array formulas to the rescue! Mr. Rogerson can accomplish his mission by writing this:

```
=SUM((A1:A15="<")*1)
```

and pressing **Ctrl-Shift-Enter** (not merely **Enter**) to terminate the formula. This formula works as follows. For each cell in A1:A15, Excel compares the cell's value with "<" and returns either **TRUE** or **FALSE**. Then it multiplies either **TRUE** by 1 (returning 1) or **FALSE** by 1 (returning 0). Finally, it adds up all the 1s and 0s, returning the number of occurrences of "<" in A1:A15.

Array formulas can also accomplish conditional counts involving two or more **ANDed** conditions. For example, suppose you want the number of values in A1:A15 that are greater than 500 and less than 600. **COUNTIF()** won't help you here, since it accommodates one condition only. You can use **DCOUNT()**, but **DCOUNT()** is a hassle, because it requires you to set up criteria ranges on the worksheet. The following array formula does the job:

```
=SUM((A1:A15>500)*(A1:A15<600))
```

(Here again, to signal that the formula is an

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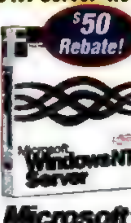
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array, you have to terminate with Ctrl-Shift-Enter.) This formula evaluates two propositions for each cell in A1:A15. At each stop along the way, it multiplies TRUE by TRUE, TRUE by FALSE, FALSE by TRUE, or FALSE by FALSE. The product of TRUE and TRUE is 1, while all the other products are 0. So after the summing up, you get the total number of cells that meet both criteria.

This technique can be extended to more than two criteria. For example, the array formula

```
=SUM((A1:A15>500)*(A1:A15<600)*(A1:A15<>550))
```

returns the number of cells in A1:A15 whose values are greater than 500, less than 600, but not equal to 550.—*Craig Sinson*

DATABASES

Preparing Your Access Apps For the Year 2000

How do I check my Access applications for problems that may occur relating to the year 2000? Will updating to the most current version of Microsoft Access automatically solve these problems?

DAVID VANDERWAL
Portland, Oregon

PC MAGAZINE: Upgrading your applications to the most recent version of Microsoft Access (Microsoft Access 97 SR-1 as of this writing) is a good idea and something I nearly always recommend, but it will not automatically solve your year 2000-related problems. The only way to do so is to review your application thoroughly—including not just the program code but all database objects, the data itself, and data sources—with an eye out for year 2000-related issues. Before attempting this review, you'll want to get yourself up to speed regarding just what these year 2000 issues are and how you should handle them.

The crux of the problem is that you cannot accurately determine the century from a date containing only two digits for the year. All you can do is make an assumption, and for some time now the assumption has been that any year represented by only two digits must be in the 20th century and therefore begin with 19. Clearly that stops working in the year 2000.

More recently, programmers have employed a *boundary* algorithm to make an assumption about whether a two-digit year represents a date in the 20th or 21st century. This involves selecting a pivot number, such as 29, and then deciding that any two-digit year less

than or equal to 29 belongs in the 21st century (begins with 20) and any two-digit year after 29 begins in the 20th century (begins with 19). This is the algorithm used by many of Microsoft's recent products, including Microsoft Access 97. It's often called a *sliding*

application for the year 2000 can be tedious, error-prone, and very time-consuming. Total Access Inspector 2000 is a detective that searches through your Access database and helps you find potential year 2000 problems. You can then view or print a variety of reports

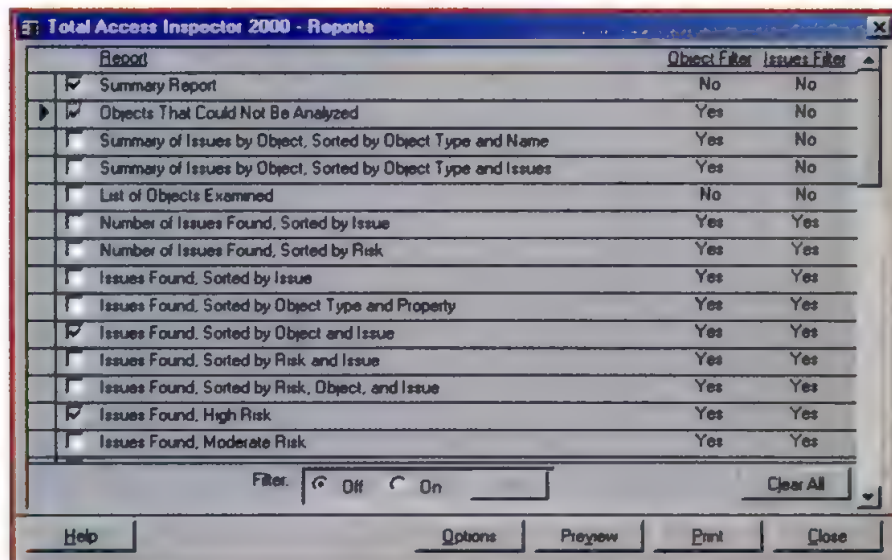


FIGURE 1: FMS's Total Access Inspector 2000 can analyze your Microsoft Access application and produce a variety of reports pinpointing items you need to review for compliance.

window technique, because the boundary must slide forward over time for the technique to be effective.

Unfortunately, the algorithm used and the century assumptions made depend on both the product and the version (they're different for each version of Access, for example), and even determining that is only the tip of the iceberg. To prepare an application for the year 2000, you must ultimately find, examine, and verify every use of a date throughout your entire database and application. The only way to make an application bulletproof is to convert every use of a date to one that employs a full four-digit year.

The best way to get up to speed on these issues and their effects on your Microsoft Office applications is to download a white paper put together by FMS. It's called "Solving the Year 2000 Problem in Microsoft Desktop Application Programs" and can be found at the FMS Web site, www.fmsinc.com. FMS designs and develops many of the best Access add-on products I've seen, so it's no surprise that the company has put together an excellent discussion of this problem. The paper explains the year 2000 problem as it relates to Microsoft Access, Visual Basic, Excel, Word, Outlook, and VBA and recommends a specific approach to fixing year 2000 problems.

FMS has also created a \$499 Access add-on that I highly recommend, because preparing an

that highlight the objects and items you need to review (see Figure 1). It doesn't do the fixing for you and there are some types of problems it can't detect, but it'll give you a long head start.

I also recommend that you review Microsoft's published year 2000 recommendations and publications, available by navigating to www.microsoft.com/year2000/ on the Microsoft Web site. A lot of useful information on Access-related issues is available there.—*Sal Ricciardi*

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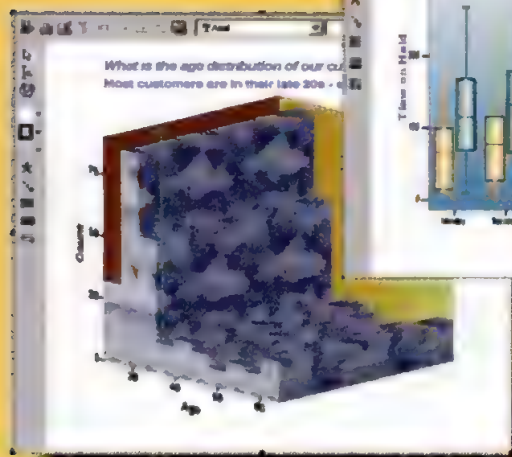
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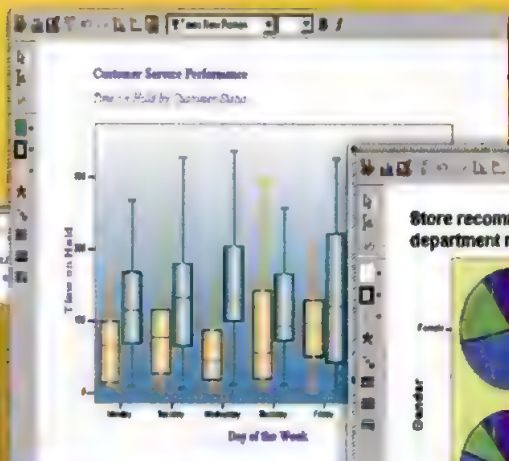
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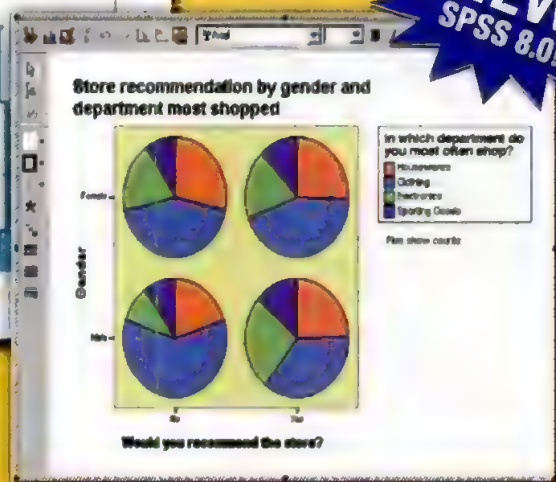
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560Z 233/Pii 32MB	
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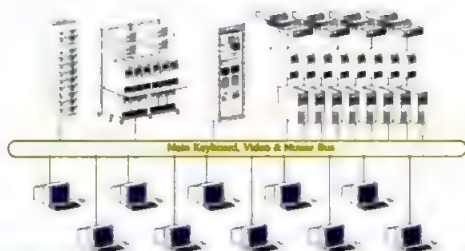
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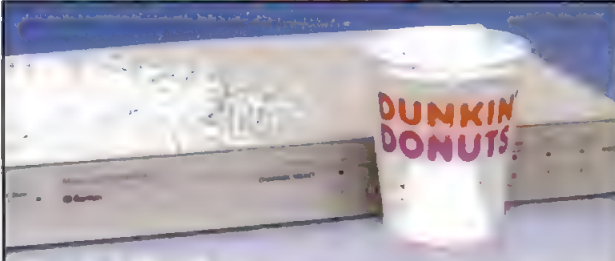
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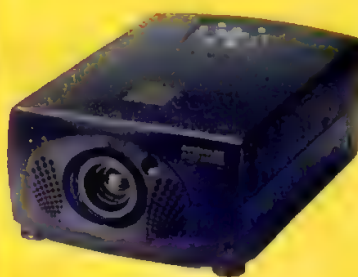
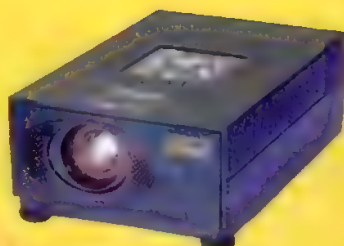
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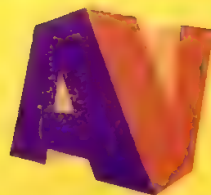
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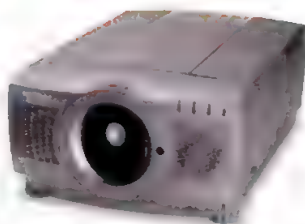
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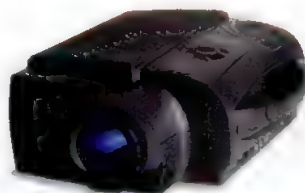
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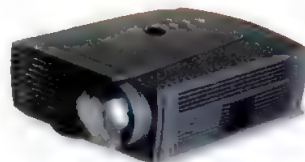
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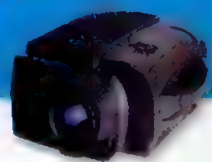
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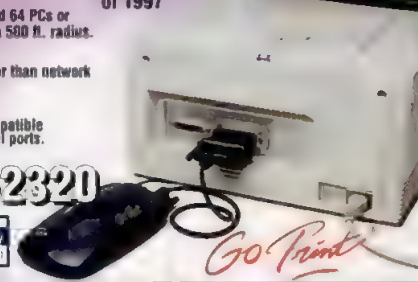
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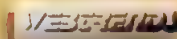
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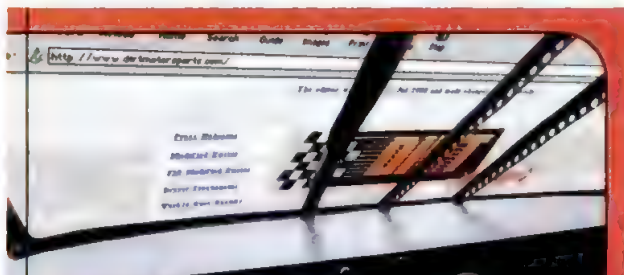
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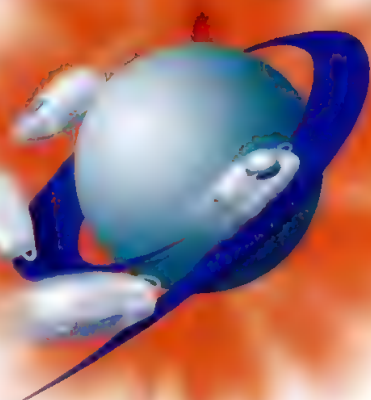
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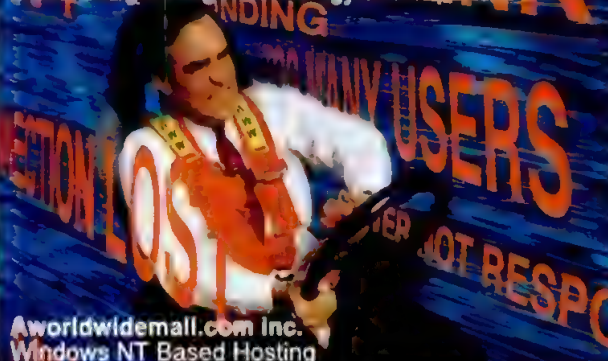


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SDRAM DIMMS (168 pin)

SDRAM - 66MHz, 100MHz, 133MHz	30 Pin	72 Pin	168 Pin
66MHz	2.30	3.00	3.00
100MHz	2.30	3.00	3.00
133MHz	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00

CPU CHIPS

Processor	Cache	Price
Pentium 486 MHz	385	100.00
Pentium 500 MHz	415	100.00
Pentium 550 MHz	445	100.00
Pentium 600 MHz	475	100.00
Pentium 650 MHz	505	100.00
Pentium 700 MHz	535	100.00
Pentium 750 MHz	565	100.00
Pentium 800 MHz	595	100.00

72 PIN DIMMS (SIMM)

SDRAM - 66MHz, 100MHz, 133MHz	30 Pin	72 Pin	168 Pin
66MHz	2.30	3.00	3.00
100MHz	2.30	3.00	3.00
133MHz	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00

30 PIN DIMMS

SDRAM - 66MHz, 100MHz, 133MHz	30 Pin	72 Pin	168 Pin
66MHz	2.30	3.00	3.00
100MHz	2.30	3.00	3.00
133MHz	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00
168 Pin	2.30	3.00	3.00

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ACER 8000	8000 MB	450.00
ACER 16000	16000 MB	850.00
ACER 32000	32000 MB	1500.00
ACER 64000	64000 MB	2800.00
ACER 128000	128000 MB	5200.00
ACER 256000	256000 MB	9500.00
ACER 512000	512000 MB	17500.00
ACER 1024000	1024000 MB	32000.00
ACER 2048000	2048000 MB	58000.00
ACER 4096000	4096000 MB	105000.00
ACER 8192000	8192000 MB	195000.00
ACER 16384000	16384000 MB	360000.00
ACER 32768000	32768000 MB	650000.00
ACER 65536000	65536000 MB	1200000.00
ACER 131072000	131072000 MB	2200000.00
ACER 262144000	262144000 MB	4000000.00
ACER 524288000	524288000 MB	7500000.00
ACER 1048576000	1048576000 MB	14000000.00
ACER 2097152000	2097152000 MB	26000000.00
ACER 4194304000	4194304000 MB	48000000.00
ACER 8388608000	8388608000 MB	90000000.00
ACER 16777216000	16777216000 MB	165000000.00
ACER 33554432000	33554432000 MB	300000000.00
ACER 67108864000	67108864000 MB	550000000.00
ACER 134217728000	134217728000 MB	1000000000.00
ACER 268435456000	268435456000 MB	1800000000.00
ACER 536870912000	536870912000 MB	3300000000.00
ACER 1073741824000	1073741824000 MB	6000000000.00
ACER 2147483648000	2147483648000 MB	11000000000.00
ACER 4294967296000	4294967296000 MB	20000000000.00
ACER 8589934592000	8589934592000 MB	37000000000.00
ACER 17179869184000	17179869184000 MB	68000000000.00
ACER 34359738368000	34359738368000 MB	125000000000.00
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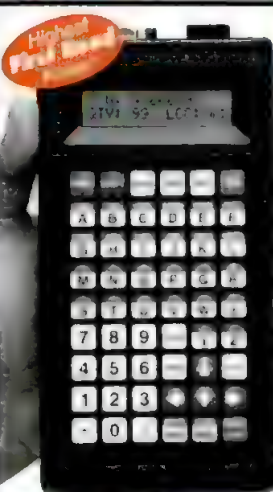
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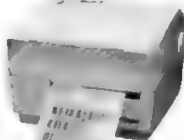


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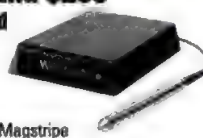
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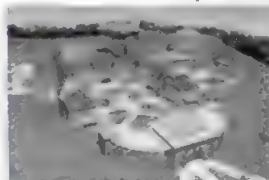
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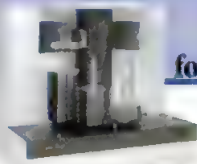
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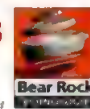
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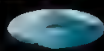
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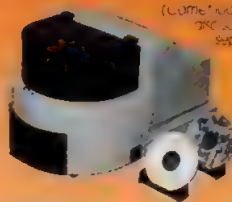
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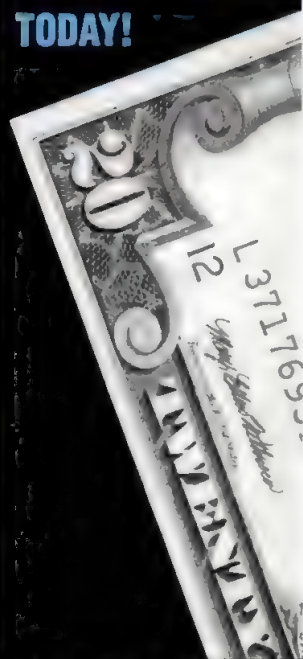
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After Hours

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These five specialty printers give you photo-quality results—no darkroom required.

By Bruce Brown

Most ink jet printers do a respectable job printing photos, but special-purpose photo printers take output to the next level. To determine just how good home photo printing can be, we tested the Canon BJC-7004 Photo (\$350 street) and the Canon CD-200 (\$500), the Epson Stylus Photo EX (\$500), the HP PhotoSmart Photo Printer (\$300), and the Olympus P-300 Personal Photo Printer (\$400). The results proved that quality photo printing is no longer limited to labs and studios.

Printing high-quality glossy photos isn't cheap: Figure 50 cents to \$1.00 apiece for ink and media, depending on the printer and photo size. All of the manufacturers are happy to sell you a variety of special-purpose papers and are probably even happier to sell high-profit margin ink cartridges and ribbons.

For an all-purpose printer that specializes in photos but also prints text and graphics, choose the Canon BJC-7004 Photo or the Epson Stylus Photo EX, our Editors' Choice; the latter can handle larger media. For photo-only printing, the low-priced HP PhotoSmart Photo Printer does a great job on conventional-size glossy paper, while the Canon CD-200 and the Olympus P-300 Personal Photo Printer print excellent photos on special snapshot-size media. In most cases, the quality of the output rivals that of

conventional film. So load up on paper and ink, because before long, you'll be churning out prints for your wallet, your wall, and your refrigerator.

Canon BJC-7004 Photo

Are you in the market for a new printer for a full range of printing jobs? The Canon BJC-7004 Photo ink jet is worth your consideration. The less expensive of the two dual-purpose photo printers here (it prints text as well), the BJC-7004 is a fine printer for

white printing. About the size of a typical ink jet printer, the BJC-7004 did a good job of printing photo images in our testing, though the quality did not quite come up to the levels set by the photos-only Epson Stylus Photo EX and HP PhotoSmart Photo Printer. The BJC-7004 uses Canon's waterproof inks, and there are separate ink cartridges for black-and-white and photo printing. There's also the option of purchasing the standard color ink cartridge for times when photo quality isn't a top priority.

Some test photos of faces were characterized by blotchy (*posterized*) areas rather than fine detail, but others showed terrific detail. In all cases, colors printed rich and true. A few times, the printer's paper feed

quality image in 6 minutes 48 seconds.

Canon sells a wide range of special printer-paper stock, including paper for T-shirt transfers and greeting cards. The BJC-7004 comes with Canon Creative 3—software titles for designing, editing, and managing graphics and photographic projects, plus software for capturing information and images from the Internet.

Canon CD-200

One of our favorite printers in this roundup is the Canon CD-200. Its high points are versatility, ease of use, speed, and print quality. The CD-200's only drawbacks are its limited 4- by 6-inch media size and relatively high price (\$500 street).

The little CD-200 has the most input options of the printers we tested, starting with jacks to print from both PCs and Macintosh computers (but not the new iMac, which has a USB port). A CompactFlash disk slot reads images taken by a Canon PowerShot camera and stored on CF media. It can also capture images directly from video



general-purpose as well as photo printing. It creates high-quality (but not class-leading) photo images.

The printer's maximum resolution is 1,200 by 600 dots per inch in color and black-and-

pushed through multiple sheets of media, but most of the time it worked correctly.

In photo-printing speed testing, the BJC-7004 was equal to the PhotoSmart, and it printed a 5- by 7.5-inch high-

INSIDE



THE X-FILES GAME

Though you get to join agents Dana Scully and Fox Mulder on a case, game play is less than x-citing. *Page 370.*

After Hours

cameras, television, laser disk, VCR, or DVD players via composite and S-Video input jacks. With the CD-200's CF slot or video input, you don't need a PC to get film-quality photo prints.

The CD-200 is a dye-sublimation printer that prints at a maximum of 288 dpi. Dye sublimation is a process that uses heat to apply and blend colors onto special media. These media are sold in boxes (\$30 street) that include an ink ribbon cartridge and either 50 sheets of regular glossy photo paper or 25 sheets of paper with 16 removable stickers per sheet.

Printing is fairly quick with the CD-200, taking just under 2 minutes to print a 3- by 4.5-inch photo. Using the default settings for highest-quality output, the Canon produced gorgeous, shiny prints that were almost indistinguishable from film prints. The video capture feature works quickly and easily; as you get to a scene you want to capture, you push a large button marked Memory and then the Print button. Less than 2 minutes later, a great print emerges from the printer.

Print size is limited, and you pay a fixed cost of about \$0.60 per print. But the Canon CD-200 is a super choice if you want to create snapshot-size photos.

Epson Stylus Photo EX



Easily the most versatile of the tested printers, the Epson Stylus Photo EX is able to print on media up to 11 inches wide, at a maximum 1,440- by 720-dpi resolution. The Photo

EX ink jet was the most expensive of the three full-size photo printers, but it produced



the best image prints and was even marginally faster than the two others. Print quality and varied-size media are the reasons to choose the Photo EX, our printer of choice in this roundup.

The Photo EX's printer driver has settings for media up to 11 by 17 inches, and it can also print on special panoramic banner stock (up to 44 inches long). Epson sells a wide variety of paper and other special media, including glossy 8.5- by 11-inch paper,



as well as the oversize formats. You can also buy card and sticker stock. While discussing paper, we should note that though each manufacturer

sells its own brand, we found virtually no difference when we swapped brands, using Canon paper in the Epson printer, for example.

On our speed tests, the Photo EX edged out the full-size BJC-7004 and the PhotoSmart, printing a top-quality photo image measuring 5 by 7.5 inches in 6 minutes 25 seconds. You certainly can't call that time speedy, though it was a little faster than the other two ink jet printers. The wait, however, pays off, for the Photo EX had the best combination of image smoothness, realistic colors, and accurate detail without posterization. The unit even managed to portray depth in photos, an area where the other printers were lacking. For example, in a close-up shot of the face of a dog, the Photo EX clearly shows more detail in the dog's dark eyes.

Like the Canon BJC-7004, the Epson Stylus Photo EX comes bundled with several software titles, and includes a program that stitches photos together to create a panorama, as well as a tutorial on taking better photos.

Though it's the most expensive of the large-format photo printers, the Epson Stylus Photo EX proves its worth. If you don't need to print on 11-inch-wide media, consider the Epson

Stylus Photo 700, which uses the same printing technology as the Photo EX and sells for a compelling \$280 (street). In this narrow-carriage version, the Photo EX's printer still provides the best print quality at competitive speed and is able to print on 44-inch-long panoramic media.

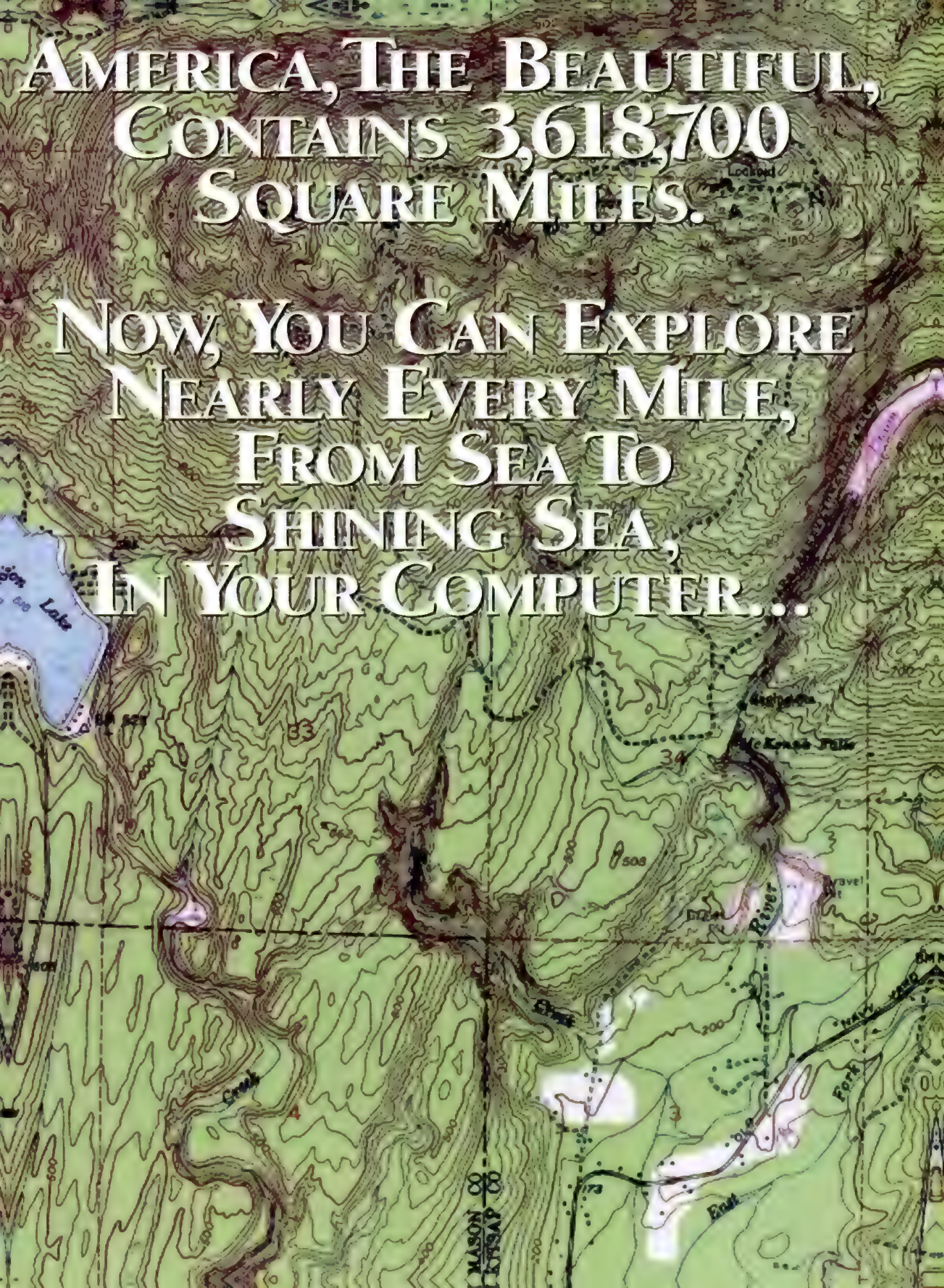
HP PhotoSmart Photo Printer

The least expensive of the tested photo printers is also one of the best at creating quality photographic prints.



Unchanged since its 1997 introduction (except for price decreases), the HP PhotoSmart Photo Printer is by far the largest of the tested printers, taking more desk space than most PCs. Though the PhotoSmart is able to create text and conventional graphics, it's not intended or recommended for those uses. For use solely printing photo images, particularly on the company's heavy photo stock, the PhotoSmart is a great performer.

The unit measures 6.5 by 18.5 by 28.8 inches, with a 40-sheet paper tray that pulls out from the lower-front of the printer and accepts media sized from 4 by 6 inches to 8.5 by 11 inches. HP doesn't rate the resolution of the PhotoSmart, but the printer uses two cartridges of three dye-based colors



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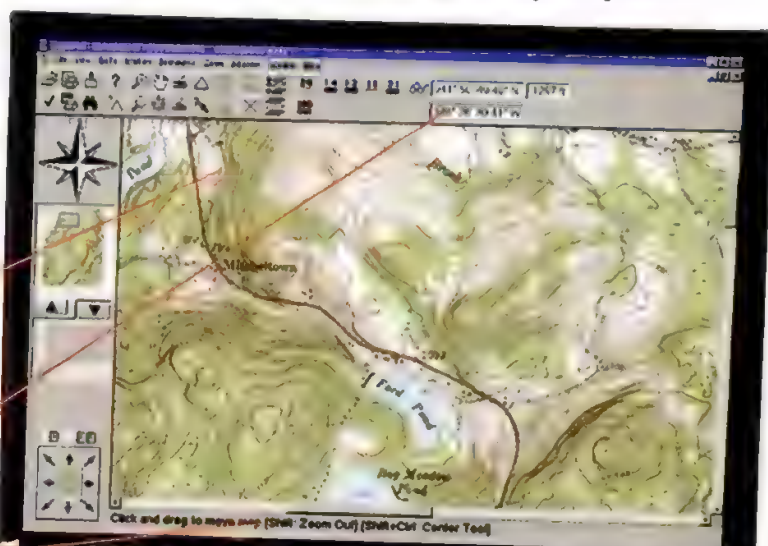
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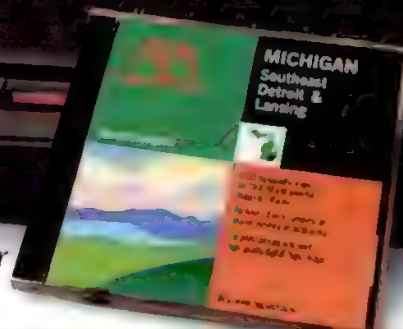
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Terrain Navigator



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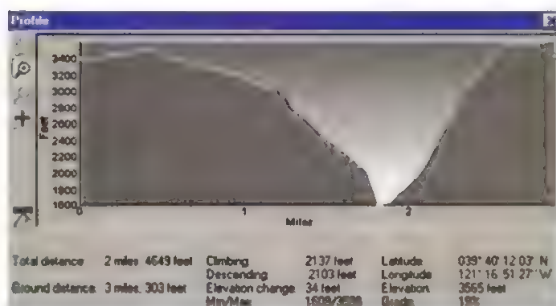
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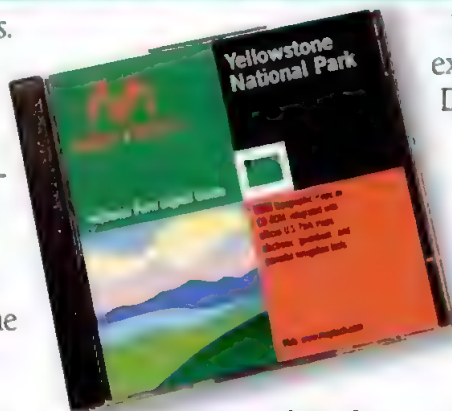
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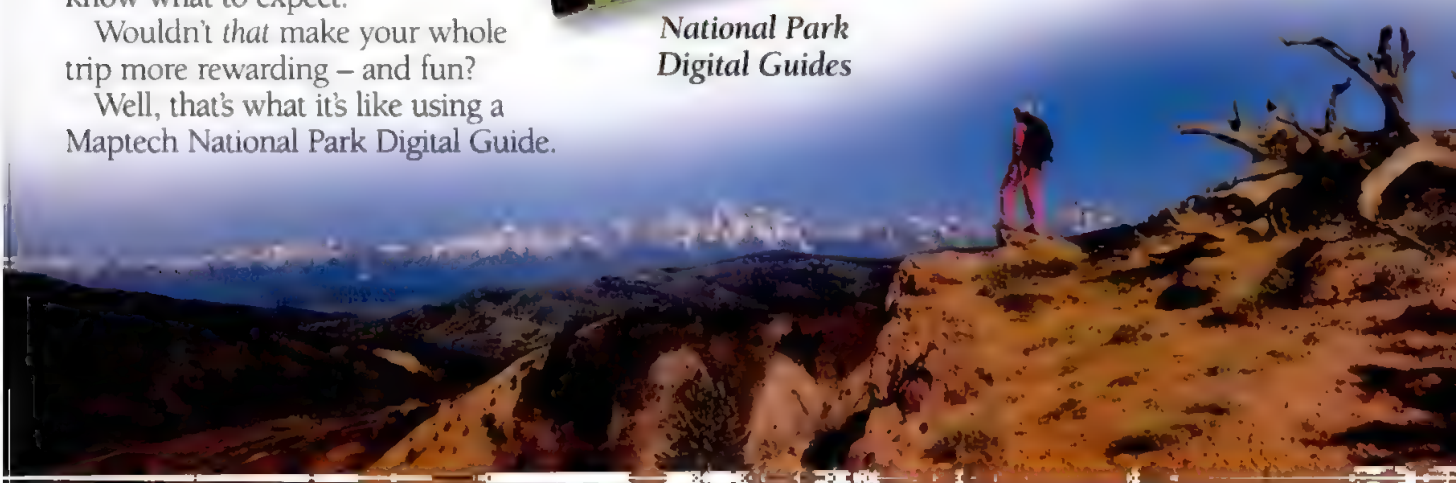
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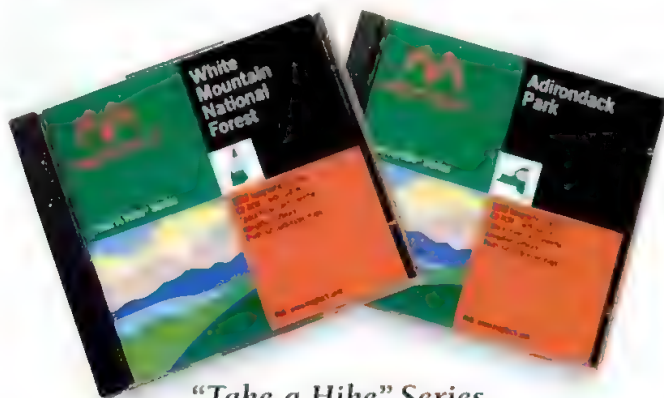
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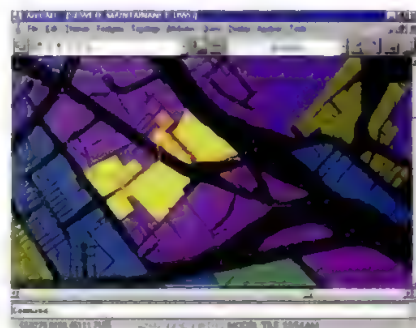
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simultaneously, with eight saturation levels. The printer is optimized for printing on glossy and matte photo paper.

Microsoft Picture It! image organization, editing, and project software is bundled with the PhotoSmart printer. Like Canon and Epson, HP sells a wide variety of paper stock, including different sizes and weights, plus special-purpose media for greeting cards and other projects.

Quality test samples with the PhotoSmart were printed on plain paper, HP-brand coated media, and heavy, glossy photo stock. The lighter-weight images were acceptable, but the output on heavy, glossy paper was stunning. On closer inspection, the images didn't appear to have the same depth as some of the images printed with the Epson Photo Stylus EX, but they were very sharp and smooth with fine detail and color. Many were suitable for framing.

The PhotoSmart isn't a fast printer by any normal measure, but it took about as long

as the Canon and Epson ink jet printers to print: 6 minutes 48 seconds to print a 5- by 7.5-inch photo on glossy stock in top-quality mode.

If you need a printer only for photographic tasks, the HP PhotoSmart Photo Printer is a bargain, although Hewlett-Packard has said that it won't update this model—a sign that the unit may be discontinued.

Olympus P-300 Personal Photo Printer

Like the Canon CD-200, the Olympus P-300 Personal Photo Printer uses dye-sublimation technology, printing from ribbon cartridges that are sold in packs with special media. In keeping with the dye-sub technology, the Olympus creates only snapshot-size output.

The P-300 is less expensive than the Canon CD-200 printer, but it lacks the CD-200's CF slot and video input. The P-300 does have a jack for direct connection to Olympus digital cameras, though, which gives you the ability to print

directly from a camera without running a PC.

Three different media/ribbon packs are available for the unit: a 60-sheet print pack (\$39.95 list price), a 60-sheet 1-cut sticker pack (\$64.95), and a 60-sheet 16-cut sticker

prints on a single page.

The Olympus printer is simple to set up. Although you have to be careful with the delicate ink ribbon, you can fix tears with adhesive tape if necessary. There are fewer buttons on the P-300 than on the CD-200, because the Olympus model does not have the ability to work with as many types of input.

Photo images that we printed with the Olympus P-300 Personal Photo Printer were impressive in their detail and their smoothness, although they didn't appear to have quite the same depth as prints from the Canon CD-200.

In some lighting, the images appeared to have a slight metallic effect.

The Olympus P-300 Personal Photo Printer is the printer to choose if you want very high-quality snapshot prints without the higher price of the Canon CD-200.



SUMMARY OF FEATURES

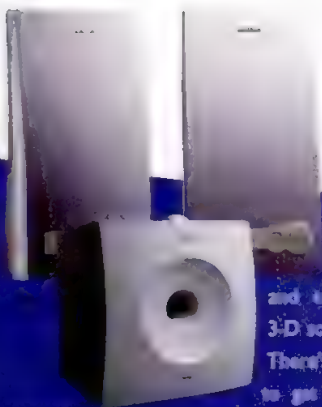
Photo Printers

PC MAGAZINE
EDITORS' CHOICE

	Canon BJC-7004 Photo	Canon CD-200	Epson Stylus Photo EX	HP PhotoSmart Photo Printer	Olympus P-300 Personal Photo Printer
Street price	\$350	\$500	\$500	\$300	\$400
Maximum media size (inches)	8.5 x 14.0	4.0 x 5.5	11.0 x 17.0; 8.5 x 44.0	8.5 x 11.0	4.0 x 6.0
Printing technology	Thermal ink jet	Dye sublimation	Thermal ink jet	Thermal ink jet	Dye sublimation
List price of consumables	Black printhead (300 pages, 5% coverage) \$39.50; color printhead (4,000 pages, 5% coverage) \$36.95; photo printhead (2,000 pages, 15% coverage) \$52.50; color ink tank (640 pages, 15% coverage) \$20.95; photo ink tank (360 pages, 15% coverage) \$31.50	50 sheets of postcard paper with ink ribbon, \$30; 25 sheets of 16 labels with ink ribbon, \$30	Black cartridge (540 pages, 15% coverage), \$21; color cartridge (220 pages, 15% coverage), \$17	\$40 each for two required three-color ink cartridges (page estimates not available)	60 sheets of paper with ink ribbon, \$39.95; 60 sheets of 1-cut sticker paper with ink ribbon, \$64.95; 60 sheets of 16-cut sticker paper with ink ribbon, \$74.95
Printer dimensions (HWD, in inches)	11.8 x 18.3 x 19.0	3.5 x 9.8 x 13.3	10.8 x 21.0 x 25.3	6.5 x 18.5 x 28.8	3.0 x 10.8 x 14.0
Data interface	Parallel port	Parallel port, Macintosh serial port, CompactFlash card slot, composite and S-Video cable inputs	Parallel port, Macintosh serial port	Parallel port	Parallel port, direct connection with Olympus digital cameras
Typical time to print, in minutes:seconds (image size, in inches)	6:48 (5.0 x 7.5)	1:50 (3.0 x 4.5)	6:25 (5.0 x 7.5)	6:48 (5.0 x 7.5)	2:10 (3.0 x 4.5)
Bundled software	ColorDesk Photo, Color Store, CreateCard SE, Design Essentials, Web Record	None	Adobe PhotoDeluxe 2.0, Extensis Portfolio, Epson PhotoSheet, Learning to See Creatively, Spin Panorama	Microsoft Picture It!	None



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Surveying the Samples

At PC Magazine Labs, we put each of the five printers through its paces—testing everything from setup to driver installation to print speed. Of course, none of the tests mean much if the printer's output quality is poor. So we placed a high premium on good-looking print samples.

To ensure a fair testing base, we used 11 photographs and printed them using the paper provided by the manufacturers

(from plain paper to glossy photo stock). The photos included subjects as diverse as a flower, a parade, a football player, and the dog and lighthouse pictured below. They were culled from photo CDs, a scanner, a digital camera, and the Internet.

The pictures seen here were scanned at 100 percent resolution, which is why samples from the CD-200 and the P-300 (both small format printers) appear smaller than the other three.

Canon BJC-7004 Photo



Canon BJC-7004 Photo



Canon CD-200



Canon CD-200



Epson Stylus Photo EX



Epson Stylus Photo EX



HP PhotoSmart Photo Printer



HP PhotoSmart Photo Printer



Olympus P-300 Personal Photo Printer



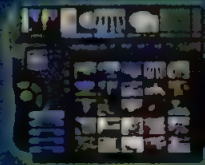
Olympus P-300 Personal Photo Printer



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Model	5870	7770	7770 RD	7695	9695	2595
CRT Type	15"	17"	17" Short Neck	17" High Contrast	19" High Contrast	21"
viewable Area	14"	16"	15.7"	15.7"	18"	19.5"
Dot Pitch	28mm	27mm	27mm	26mm	26mm	25mm
Horiz. Frequency	30~70 khz	30~70 khz	30~70 khz	30~95 khz	30~95 khz	30~95 khz
Max. Resolution	1280 1024	1280 1024	1280 1024	1600 1200	1600 1200	1600 1200
On-Screen Menus	Yes	Yes	Yes	Yes	Yes	Yes
*CO option	TCO 95	TCO 95	TCO 95	TCO 95	TCO 95	TCO 95
Win 98 ICM profile*	Available	Available	Available	Available	Available	Available

* Windows 98 ICM profile: For display to printer WYSIWYG Windows 98 requires a Multigrip Color Matching profile for the display monitor. This profile is available free of charge at the place of purchase or directly from Hyundai.



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X-Cruciating

In The X-Files Game, the truth is out there, but it isn't very pleasant.

Some things in the computer industry never change. Most PCs will always be beige, and gaming companies will try their hardest to suck the life out of even the most promising television franchises. Unfortunately, Fox Interactive's *The X-Files Game* adds plenty of reinforcement to that last axiom. The game is little more than a mediocre episode whose momentum is hindered by pointless player interaction.

Actually, "interaction" is a misnomer. The use of the word seems to imply that the player's actions within the game actually have some bearing on the outcome, which is not the case.

You play FBI agent Craig Willmore, a Seattle-based agent assigned the task of tracking down Agents Mulder and Scully, who are noticeably absent from their Washington D.C. headquarters—as well as from most of the game (they don't appear until disk six of seven).

It's typical full-motion video gaming fare. Enter a room, click on hot spots, gather the available objects and move on to the next scene.

You also meet a few characters, and can ask them questions such as "Are Mulder and Scully romantically involved?" You get your pat answer and then move on to the next question (the questions serve more to give you something to do than to move the plot along).

This is not to say, however, that the game is entirely

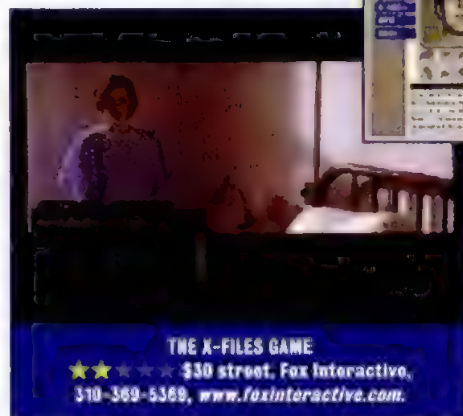
bad. The full-motion video sequences are some of the best ever to grace a PC game, and they no doubt account for this surprisingly short game's seven disks. Also, the acting is quite good, considering that you're dealing with TV actors, though our heroes look a tad bit

uncomfortable with this new medium.

If you're a true X-Phile, bent on following anything Scully and Mulder,

you won't mind what is essentially a linear, mildly interactive episode. But if you're a gamer looking for adventure with your favorite FBI agents, the truth is out there, and it is that you should trust no one who tells you this title is good.—Shane

Mooney **PC**



Coming Up

What's in the Next Issue of *PC Magazine*

Buy It on the Web

With the holiday season approaching, we'll test more than 60 Web sites that sell computers, books, and more, and tell you which sites stand out. Find out which site delivers the best shopping experience and where you can find the best deals.

Web Storefront Creation

If the complexity and cost of creating a Web storefront have deterred you from setting up shop online, here's the perfect answer. Our story will target small-business solutions that combine the basic software tools you need to build your store with Web hosting services.

Windows NT 5.0 Beta 2 Preview

Beta 2 of Microsoft's enterprise-strength server and workstation OS has been released, and we'll give you an inside look at the features of the next major operating system coming out of Redmond.

Virtual Private Networks

VPNs create secure tunnels through the Internet that let remote users and branch offices connect to your corporate network. We'll test six of these new products.



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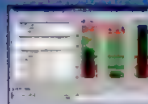
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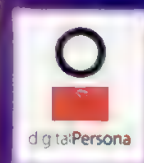
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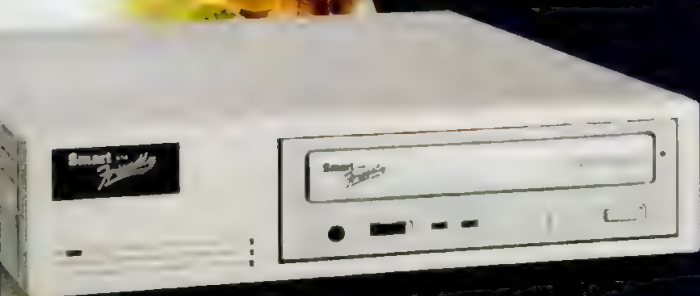
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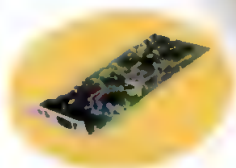
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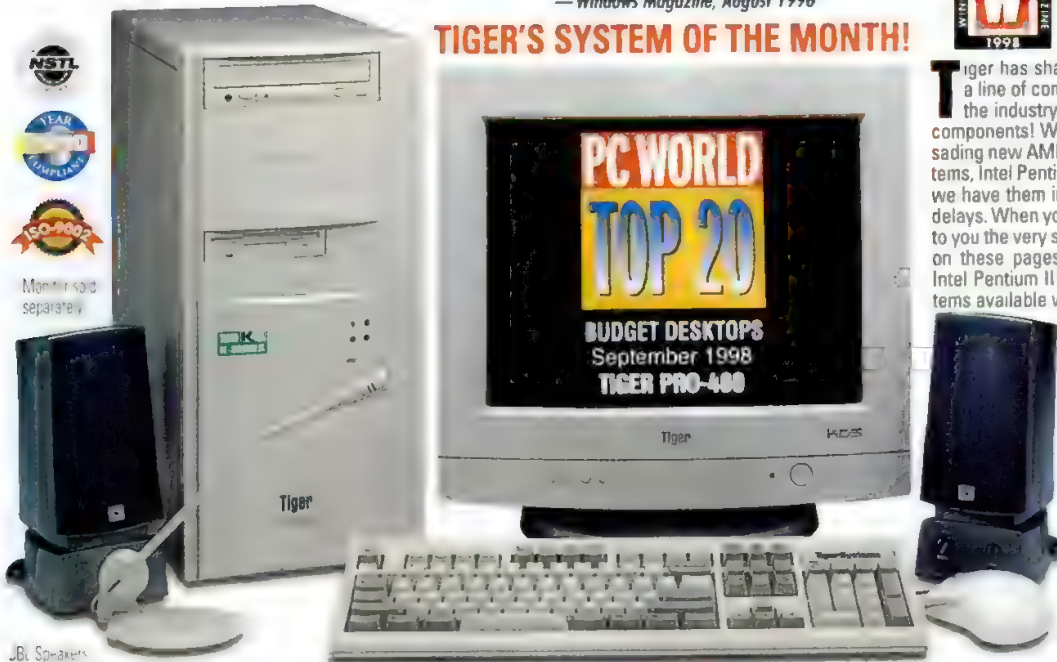
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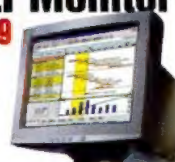
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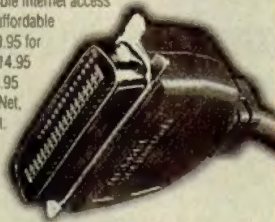


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Internet  access via a printer cable? Neat trick. (InfiNet ad.)

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Grammar Checkered

InfoWorld recently ran a story called "Strong Writing Skills Essential for Success, Even in IT." Here's the first sentence of the story: "No matter how good your technical skills, are you probably won't move up the IT career ladder unless your writing measures up."

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